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PERSONNEL CERTIFICATION IN INDUSTRIAL MAINTENANCE SERVICES

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Abstract

The shift of manufacturing companies entering industrial maintenance service business has created new challenges for the companies triggering the need to focus more on managing the intangible assets and the service personnel. This master's thesis examines personnel certification in industrial maintenance services. The thesis objective is to study if personnel certification is beneficial for companies in industrial maintenance services and in assuring field service engineer competence. Research was conducted as a qualitative multiple case study examining five cases globally. The matter expert or the responsible manager for the personnel certification activity in each case organization was interviewed via conducting open-ended interviews during April-July 2013.

According to the findings, professional maintenance personnel certification offered by third parties is not purchased by the case organizations. Instead, internally standardized personnel certification seems an emerging trend in industrial maintenance service organizations. Organizations have developed in-house certification programs for certifying personnel. Furthermore, some industrial maintenance service companies practice accredited personnel certification where the certification activity run by company itself is approved by an external authority. The requirements from industry authorities and customers play an important role in leading to accredited certification.

The findings also indicate that field service engineer certification benefits companies by enhancing internal efficiency and providing quality assurance on performed service work and personnel competence. For the accredited certification cases, the evaluated benefits of personnel certification also included assurance on safety and useful legal evidence on competence development and assessment. The internally standardized certification cases assumed also that enhanced service quality resulting from personnel certification will eventually lead to increased service business. Nevertheless, personnel certification seems to come with significant time and resource tradeoffs, and personnel certification was experienced challenging in general. In the case organizations primary focus was given to assuring technology and product specific competences, and other competence related to the QEHS policies and procedures, workplace communication, and teamwork. The soft (or relational) skills, that were emphasized in the literature for being critical in creating service quality, were neglected in the case organizations.

The thesis provides new knowledge to both the competence management field, and the research field of industrial services and maintenance services. As practical implications, the thesis provides a framework for evaluating the benefits and tradeoffs related to different approaches to running an in-house personnel certification program, and company's ability to pursue it.

Keywords Competence management, competence development, competence assessment, personnel certification, industrial services, maintenance services, service engineer

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Tiivistelmä

Teollisuusyritysten lisätessä palveluita tarjoamaansa on syntynyt uusia haasteita, mikä on käynnistänyt tarpeen keskittyä yhä enemmän hallitsemaan yritysten aineetonta pääomaa ja huoltohenkilöstöä. Tämän diplomityön tavoitteena on tutkia henkilösertifioinnin hyödyllisyyttä teollisuuden huollon palveluyrityksille ja hyödyllisyyttä palveluinsinöörien osaamisen todentamisessa. Tutkimus toteutettiin laadullisena moni-case tutkimuksena ja tutkimus tarkasteli viittä case-organisaatiota maailmanlaajuisesti. Jokaisessa case-organisaatiossa aiheen asiantuntijaa tai henkilösertifioinnin vastuullista päällikköä haastateltiin avorakenteiseen haastatteluun pohjautuen huhtikuu-heinäkuu/2013 välisenä aikana.

Tutkimustulosten mukaan case-organisaatiot eivät hanki kolmansien osapuolien tarjoamia huoltohenkilöstön ammatillisia sertifikaatteja. Sen sijaan yrityksen itsensä sisäisesti standardoima henkilösertifiointi vaikuttaa olevan uusi suuntaus teollisuuden huollon palveluorganisaatioissa. Organisaatiot ovat kehittäneet sisäisen sertifiointiohjelman henkilöstön sertifioimiseksi. Lisäksi, jotkut teollisuuden huollon palveluyritykset harjoittavat akkreditoitua henkilösertifiointia, jossa yritys itse harjoittaa sertifiointitoimintaa, mutta toiminta on ulkoisen auktoriteetin hyväksymä. Teollisuuden alan auktoriteettien sekä asiakkaiden vaatimukset ovat merkittäviä tekijöitä ohjaamaan akkreditoituun sertifiointitoimintaan.

Tutkimuksen tulokset osoittavat lisäksi, että palveluinsinöörin sertifioinnista seuraa yrityksille hyötyjä, kuten sisäisen tehokkuuden parantuminen sekä laadusta varmistuminen toteutettavien palvelutöiden ja henkilöstön osaamisen osalta. Akkreditoidun henkilösertifiointitoiminnan hyödyiksi arviointiin lisäksi varmistuminen turvallisuudesta sekä hyödyllisen lain hyväksymän todistusaineiston karttuminen osaamisen kehittämisen ja arvioinnin seurauksena. Organisaatiot, joissa henkilösertifiointi oli sisäisesti standardoitua, olettivat myös, että henkilösertifioinnin seurauksena parantuva palveluiden laatu tulee aikanaan lisäämään palveluliiketoimintaa. Kuitenkin henkilösertifiointiin liittyy merkittäviä kompromisseja ajankäytön sekä resurssien osalta ja henkilösertifiointitoiminta koettiin yleisesti haasteellisena. Case-organisaatioissa osaamisen sertifiointi oli ensisijaisesti keskittynyt teknologia- ja tuoteosaamisen sekä muiden osaamisten, kuten QEHS-käytäntöjen ja -toimintatapojen sekä kommunikointi- ja tiimityöskentelykykyjen todentamiseen. Kirjallisuudessa painotettujen "pehmeiden" (tai relationaalisten) taitojen kriittisyyttä palvelun laadun tuottamisessa ei oltu huomioitu case-organisaatioissa.

Diplomityö lisää uutta tietoa sekä osaamisen johtamisen aihealueeseen että teollisuuden palveluiden ja huoltopalveluiden tutkimuskenttään. Käytännön kontribuutiona tutkimus esittää viitekehyksen erilaisten henkilösertifiointitoiminnan harjoittamisen lähestymistapojen arviointiin sekä edelleen niihin liittyvien hyötyjen ja kompromissien arviointiin. Viitekehyksen pohjalta yritykset voivat arvioida kykyään harjoittaa henkilösertifiointia.

Avainsanat Osaamisen johtaminen, osaamisen kehittäminen, osaamisen arviointi, henkilösertifiointi, teollisuuden palvelut, huoltopalvelut, palveluinsinööri

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1. INTRODUCTION

1.1 Research background and motivation

Manufacturing companies have taken the shift in their business offering from products to services (Baines et al., 2008). Manufacturing companies are now offering industrial services to support the products owned or possessed by customers (Kumar & Kumar, 2004; Brax, 2005). This shift however poses challenges, and organizational and cultural changes are required (Oliva & Kallenberg, 2003; Brax, 2005; Baines et al., 2008). New focus on company's intangible assets is required as these intangibles (assets, unique skills and organization, culture and human resource management) play a critical role in bringing competitive advantage in industrial services (Matthyssens & Vandenbempt, 1998). Hence, unlike in manufacturing, the role of people becomes fundamental in services, and they become the main asset in providing quality customer service in supporting customer goals and practices (Parasuraman et al., 1985; Bowen et al., 1989; Peterson et al., 2004).

This industry shift to services has raised attention to knowledge and competence management in companies, human resources being in the core of bringing competitive advantage and creating value (Athey & Orth, 1999; Robertson, 1999; Ellström & Kock, 2008). Competence management and intellectual capital (IC) management field provides models and practices for the challenges companies are facing. Nevertheless, research on the actual competence development practices taking place in industrial service companies is scarce. It has been criticized that what happens in companies and human resource practices has not been in-line with what has been inclined in theories (De Vos et al., 2011).

This study is made as an assignment, and in collaboration with a global, Finland based industrial technologies and services provider (herein referred to as company A) and FutIS – Future Industrial Services research program in Finland[1]. The input and motivation for this study originates from the company A's interest and challenges related to a problem on how to solve the need to assure the competence of their field service engineers who are dispersed in various locations globally. Some form of personnel certification was seen as

[1] FutIS is a 5 year FIMECC (Finnish Metals and Engineering Cluster) led research programme funded by TEKES and participating companies.

an attractive option by the company A - whether certification of an individual would be approved by the company A itself or by a third party authorization body possibly specialized in the field of concerned certification.

Certification of personnel is one method for providing assurance that an individual meets the requirements of a certification scheme (ISO/IEC 17024:2012:E). Moreover, confidence in the certification scheme is achieved by means of an accepted process of assessment and periodic re-assessments of the competence of the certified individuals. Furthermore, in the company A, field service engineer (FSE) certification was hypothesized to bridge the ongoing FSE competence mapping and the technical training structure into a more comprehensive and structured practice of competence management. The company A was interested in early conceptualizing of a personnel certification framework for their FSEs. These issues served as the basis of motivation for this research.

As the lack of existing research and practices for competence assurance and personnel certification in the context of industrial maintenance services was anticipated, the need for further empirical research was recognized.

1.2 Research problem and objectives

The objective for this research is to study if personnel certification is beneficial for companies in industrial maintenance services, and in assuring field service engineer (FSE) competence especially. Hence, the following research questions were formulated:

RQ1. What kinds of methods exist for personnel competence assurance in companies (both in general and in industrial maintenance services companies)? What are the method key elements?

RQ2. Is personnel competence assurance perceived beneficial for companies, employees, and customer in industrial maintenance services?

RQ3. How do we evaluate what field service engineer (FSE) competence is critical and how it should be assured?

1.3 Structure of the study

This thesis starts with the literature review analyzing the context of industrial services (chapter 2), and maintenance services in specific and the requirements on field service engineer (FSE) competence (chapter 3). This follows the review of competence management practices in companies (chapter 4). Finally, suitable and available methods of

competence assurance are discussed (chapter 5). These findings from the literature are then concluded in a framework of FSE competence assurance (chapter 6).

The literature review is followed by the description of the conducted multiple case study. First, the methodology for the research will be explained in detail: the research design, data collection and analysis, as well as the validity, reliability and liabilities related to the research are reviewed (chapter 7). This is followed by the research findings (chapter 8).

Finally, discussion (chapter 9) of the thesis summarizes the conducted research, answers to research questions, provides managerial implications and implications for existing literature, as well as discusses the study limitations and suggestions for further research. Figure 1. illustrates the structure of the study described above.

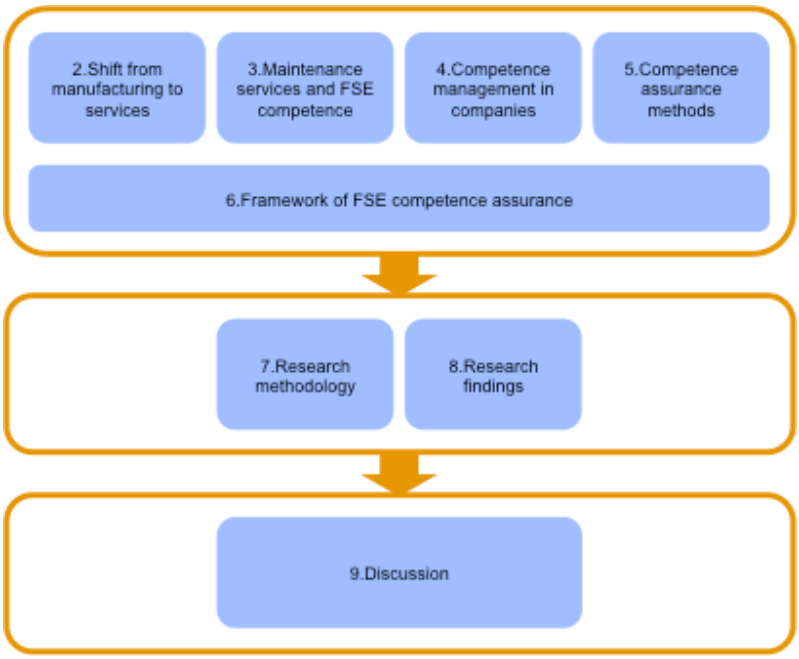


Figure 1. Structure of the thesis

2. MANUFACTURING INDUSTRY SHIFT FROM PRODUCTS TO SERVICES

This chapter analyzes the context of industrial services based on literature. First, the phenomenon of "servitization of manufacturing" is discussed, and then the challenges related to the shift to services are reviewed. Finally, the factors leading to success and competitive advantage in offering industrial services are discussed.

2.1 Servitization of manufacturing

Manufacturing companies are increasingly integrating services to their offering. This shift is often discussed in literature as "servitization of manufacturing". The term servitization was first introduced by Vandermerwe & Rada (1988) and defined as "the increased offering of fuller market packages or 'bundles' of customer focused combinations of goods, services, support, self-service and knowledge in order to add value to core product offerings". Baines et al. (2008) further adds that "servitization is the innovation of an organization's capabilities and processes to better create mutual value through a shift from selling product to selling PSS [product-service systems]".

Industrial services are business services offered by manufacturing companies to customers with industrial production and products e.g. drilling machines, mining equipment, locomotives and oil platforms (Kumar & Kumar, 2004; Brax, 2005). Industrial services include both business advisory services, and maintenance and repair services (Kotler, 1994). The services comprise conducting repairs, installing upgrades, reconditioning equipment, carrying out inspections and daily maintenance, technical support, consulting and training, and financial services (Cohen et al., 2006).

There are varying reasons why manufacturing companies are interested in adopting services to their traditional offering. According to Baines et al (2008), the drivers for servitization of manufacturing include financial, strategic and marketing factors:

> First, from financial point of view, services provide manufacturing companies e.g. with more balance and resistance to economic changes, stable and long-term revenue, higher profit margin, and business potential for the whole product life-cycle (Oliva & Kallenberg, 2003; Kumar & Kumar, 2004; Brax, 2005; Baines et al., 2008);

Second, strategic drivers mainly refer to factors of competitive advantage (Baines et al., 2008). Integrating services provides new potential for competitive advantage, opportunities of differentiation as services are more difficult to imitate (Oliva & Kallenberg, 2003), and offers a chance to create growth in matured markets (Brax, 2005);

Third, from the marketing perspective, industrial services facilitate the sales of traditional products, respond to increasing customer expectations, and lengthen customer relationships as well as give better insight to customer needs (Bowen et al., 1989; Brax, 2005; Baines et al., 2008).

Nevertheless, adopting the "servitization of manufacturing" in companies has been relatively slow (Oliva & Kallenberg, 2003; Cohen et al., 2006; Neely, 2007; Baines et al., 2008), as it requires changes in organizational and cultural contexts of manufacturing companies (Oliva & Kallenberg, 2003; Baines et al., 2008).

2.2 Servitization challenges

Services are intangible, heterogeneous, and inseparable in nature (Parasuraman et al., 1985). Due to the intangibility of services, the defining, measuring or assessing service and service quality is difficult. Services are heterogeneous, and the more people involved in performing service, the more variation there will be in service delivery and quality. Additionally, the production and consumption of many services is inseparable and take place simultaneously, and also often customer is strongly affecting the process. A fourth characteristic, perishability of service, is often added to the list, being that services cannot be stored and only exist when the service is actually produced (Baron & Harris, 2003).

Many challenges arise from the intangibility, heterogeneity, inseparability and perishability of services. Most of the potential service complexity factors recorded in the literature are related to the dimensions of service markets and products, and production processes (Benedettini & Neely, 2012). Furthermore, the quality of service is the main and most important problem area (Homburg & Garbe, 1999). In a case study (Brax, 2005) six (6) categories of servitization challenges were identified, namely marketing, production, delivery, product design, communication and relationship challenges:

Marketing challenge indicates that companies have difficulties in shifting from the ways of marketing goods to marketing services. Traditional practices are not useful anymore, and hence, challenges in co-operation with customers emerge. Many industrial service marketers lack the skills and familiarity with offering services (Homburg & Garbe, 1999; Brax, 2005);

Production challenge is mainly structural and relates to systems and resources needed to produce the service. Information on installed base equipment owned by customers is critical for planning suitable service (Brax, 2005; Colen & Lambrecht, 2013). Additionally, the lack of expert competencies and poor customer focus create challenges in service production (Mathieu, 2001);

Delivery challenges comprise cultural problems and perceived lack of customer focus (Brax, 2005). Cultural problems emerge from individual attitudes and cultural differences between the manufacturer providing service and the customer. Bad timing in the delivery of different services as part of a larger service contract, or lack of management support imply poor customer focus. Customers often seem to be unsatisfied with service delivery (Mathieu, 2001). Establishing and mastering the service network for geographically distributed installed base, and managing the product market parallel creates also challenges for the companies which slows down the progress of servitization (Oliva & Kallenberg, 2003);

Product design challenge is created mainly from the difficulties with the maintenance management strategy of a solution. Varying views exist on how the maintenance management strategy should be supporting the customers' operation, and how the maintenance should be scheduled. Additionally, different systems in maintenance information management are used by the manufacturer and the customer respectively, and that creates difficulties such as incompatibility, inflexibility, and varying quality criteria (Brax, 2005);

Communication challenge considers in general the lack of communication between the service provider and the customer. Issues such as manufacturer not creating sufficient processes to receive feedback from the customer, and the customer forced to communicate with several stakeholders from the manufacturer's side were mentioned. Insufficient field service engineer's communication is a challenge as well (Bowen et al., 1989; Brax, 2005);

Relationship challenge arises from the customer perceived service provider expertize and from the attitudes to the customer-provider relationship. Unprofessional field service engineers, unsolved problems and technical problems make the customer hesitant to invest in the manufacturer in the future. Opportunistic behavior from service provider's side and hiding information from the customer is bad for the relationship as well (Brax, 2005).

Therefore, the manufacturing companies should pay more attention to following factors:

- developing a common understanding of the service offering with the customer;
- investing in effective information system and information management practices, and ensuring that the company possesses the skills and resources needed to deliver the service;
- supporting the cultural and attitudinal change throughout the company, and creating an efficient service network;
- focusing on supporting customer's goals and practices, and gaining knowledge on the customer;
- focusing more on actually motivating the customer for the relationship, and not vice versa, as the customer is interested to have more effective relationship;
- giving special focus on the credibility of the expertise, and avoiding opportunism and problems in the service. (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Mathieu, 2001; Oliva & Kallenberg, 2003; Brax, 2005; Colen & Lambrecht, 2013)

Nevertheless, manufacturing company's capacity and willingness are critical factors in overcoming the challenges and taking servitization further (Mathieu, 2001). A secondary or inferior role of service business in a company will deprive the chance to gain the potential competitive advantage (Brax, 2005; Colen & Lambrecht, 2013).

2.3 Competitive advantage in industrial services

Competitive advantage is about performing better than competitors by possessing unique and hard to imitate resources (Matthyssens & Vandenbempt, 1998). This can be achieved through differentiation and cost-effectiveness (Matthyssens & Vandenbempt, 1998). Creating competitive advantage in industrial services is unique due to the intangibility, heterogeneity, inseparability and perishability of services resulting in challenges but also opportunities for differentiation from pure product offering (Oliva & Kallenberg, 2003; Baines et al., 2008; Edvinsson, 2013).

Several elements seem to bring competitive advantage for companies. According to Prahalad & Hamel (1990) and Hamel & Prahalad (1994), it is a continuous process of collecting industry foresight and focus on developing company core competencies that builds competitive advantage. Core competences are company's capabilities that provide: potential access to several markets or potential for market leadership; highly contribute to the end product and customer perceived benefits; and require highly specialized knowledge, and skilled and specialized assets resulting in something difficult to imitate (Prahalad & Hamel, 1990).

Especially in the context of industrial services, Matthyssens & Vandenbempt (1998) identify three (3) key factors that lead to superior customer value and competitive advantage. These include the quality of service, the ability to provide proactive and total solutions to the customer, and the ability to innovate and design new services in collaboration with the customer. These three factors are reviewed in the following sub-chapters, and finally a strategic framework to bringing competitive advantage in industrial services is reviewed.

2.3.1 Service quality

First of the three factors leading to competitive advantage is the quality of service. Manufacturer can try to affect how the customer perceives and values the quality of the service by bringing tangibility to the intangible service. Communication of the quality of intangible, and often hard to define, service to the customer should be clear, transparent and reliable in the eyes of the customer. This can be achieved through utilizing inter alia quality tools and hardware, standards and certificates, warranty offerings and reference sites. (Matthyssens & Vandenbempt, 1998)

To help understand which factors affect service quality, Homburg & Garbe (1999) suggest a triangular model of industrial service quality comprising structural quality, process-related quality, and outcome-related quality (see Figure 2.):

> *Structural quality* constitutes human resources such as the amount of service personnel, their distribution in the service network, and their qualifications; physical resources such as the number, size, equipment and geographical disposition of service locations; as well as financial resources;
>
> *Process-related quality* includes technological component and interpersonal component. Technological component of process-related quality refers to information technology and systems in the service delivery. Interpersonal component, on the other hand, refers to the service personnel or the personnel in contact with the customer, and to the attitude and behavior in the delivery of service such as friendliness, helpfulness, and objectivity in giving technical information or advice;
>
> *Outcome-related quality* comprises two types of results of the delivered service work: technical results such as an accurately working equipment after repair, and attitudinal results such satisfaction with the service result (Homburg & Garbe, 1999).

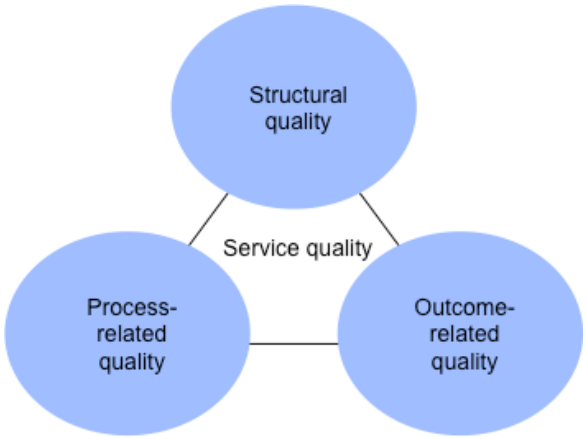


Figure 2. A triangular model of industrial service quality (adapted from Homburg & Garbe, 1999)

According to Homburg & Garbe (1999), service quality positively affects customer's trust and satisfaction. And on the other hand, unsatisfied customer is an indicator of inadequate service (Ala-Risku, 2009). Especially, the process-related quality dimension has strong effects on the relationship with the customer, affecting customer's commitment to service provider as well.

Customer's perceived service quality is affected by service provider, and more accurately by the field service engineer attributes (Parasuraman et al., 1985; Bowen et al., 1989; Peterson et al., 2004; see Table 1.). Peterson et al. (2004) identified that in the developed markets for operation critical high-tech equipment repair services the service quality affecting attributes of a service engineer include responsiveness, reliability, assurance, tangibility and empathy. Similarly, according to Parasuraman et al. (1985) and Bowen et al. (1989), the customer perceived service quality is created mostly through the intangible factors of reliability, responsiveness, competence, access, courtesy, communication, credibility, security, and understanding the customer – and through the tangibility of physical evidence in the service delivery. According to Peterson et al. (2004), the responsiveness and reliability attributes affected most strongly the service quality.

Table 1. Determinants of service quality / Service engineer attributes (based on Parasuraman et al., 1985; Bowen et al., 1989; and Peterson et al., 2004)

	DETERMINANTS	DEFINITION	EXAMPLES
INTANGIBLES	Reliability	Consistency of performance and dependency (Bowen et al., 1989) Timely delivery of what was promised (Peterson et al., 2004)	Accuracy of billing, keeping records, performing the service at the designated time
	Responsiveness	The willingness or readiness of employees to provide service (Bowen et al., 1989) Service engineer's attitude and promptness in service delivery (Peterson et al, 2004)	Calling the customer back quickly, giving prompt service
	Competence (Bowen et al., 1989) Assurance (Peterson et al., 2004)	Possession and demonstration of the required skills and knowledge to perform service Service engineer's behavior affecting customer's confidence on his/her competence	Knowledge and skill of the contact personnel and operational personnel, delivered the service
	Access (Bowen et al., 1989) Responsiveness (Peterson et al., 2004)	Approachability and ease of contact Total amount of time of equipment failure	Waiting time to receive service is not extensive, convenient hours of operation
	Courtesy (Bowen et al., 1989) Empathy (Peterson et al., 2004)	Politeness, respect, consideration, and friendliness of contact personnel Customer's experienced service attention and care from service provider	Consideration for the customer's property, clean and neat appearance of the contact personnel
	Communication (Bowen et al., 1989)	Keeping customers informed in language they can understand and listening to them	Explaining the service itself, assuring the customer that a problem will be handled
	Credibility (Bowen et al., 1989) Assurance (Peterson et al., 2004)	Trustworthiness, believability, honesty Service engineer's behavior affecting customer's confidence on his/her competence	Credibility is achieved by: company reputation, personal characteristics of the contact personnel
	Safety (Bowen et al., 1989)	The freedom from danger, risk, or doubt	Physical safety, financial security
	Understanding / knowing the customer (Bowen et al., 1989) Empathy (Peterson et al., 2004)	Making the effort to understand Customer's experienced service attention and care from service provider	Learning the customer's specific requirements, providing individualized attention
	TANGIBLES	The physical evidence	Physical facilities, appearance of personnel, tools or equipment used to provide the service (Bowen et al., 1989) Supporting equipment, tools, and documentation / service materials the service engineer used (Peterson et al., 2004)

These results from the research indicate the importance of the service delivery personnel, and the personnel in contact with the customer. Hence, service-oriented strategy should recognize the importance of intangibles (Bowen et al., 1989). According to Peterson et al. (2004), a uniform cross-regional approach to the service quality primarily creates excellence for the customer and customer's equipment operations.

2.3.2 Proactive and total solutions

Another factor that brings competitive advantage is company's ability to provide proactive and total solutions to customers in a one-stop-shop manner indicating a higher level of servitization and customer centricity (Matthyssens & Vandenbempt, 1998). Offering

services that focus supporting customer's actions and assisting the customer with their specific problems can result as "a powerful means of differentiation that customers recognize" (Mathieu, 2001).

Service that succeeds to support customer's actions and goals is a result from a favorable interaction between the customer and the service provider (Mathieu, 2001). In industrial maintenance services, Campbell (1995) and Stremersch et al. (2001) have reported that, total solution service offering increases customer loyalty as the customer will become also more reliant on the industrial service provider. For a manufacturing company providing proactive and total solutions to the customer, emphasis should be on excellent problem solving ability and high degree of customization aiming for customer satisfaction and loyalty (Boyt & Harvey, 1997). Hence, both technical expertize and customer centricity in offering service solutions become critical (Mathieu, 2001; Kowalkowski, 2008).

Technical expertize is at the core of the manufacturing company's service offering, and this has led manufacturing companies to focus more on their core competences, and outsourcing other activities (Campbell, 1995; Stremersch et al., 2001; Oliva & Kallenberg, 2003; Baines et al., 2008). "Maintenance activities for which the company has neither a strategic nor a special capability are prime candidates to be outsourced" (Tsang, 2002). Furthermore, specialized knowledge and skilled and specialized assets are required to create something difficult to imitate (Prahalad & Hamel, 1990).

Regarding customer-centricity and customer relationship, active interaction with the customer provides input for the service provider to better satisfy the customer needs, develop new offering, gain competitive advantage, and innovate (Bowen et al., 1989; Kowalkowski, 2008). According to Oliva & Kallenberg (2003), customer-centricity comprises a shift of focus from product-oriented to process-oriented services, and another shift from transaction-based to relationship-based customer approach.

2.3.3 Innovative new service design

The third factor that brings competitive advantage in industrial services is the ability to innovatively design new services in collaboration with the customer to actually solve a critical issue or problem in order to enhance customer's performance (Matthyssens & Vandenbempt, 1998). The service design process is recognized critical, but easily fails and results in poor quality (Edvardsson, 1997; Tax & Stuart, 1997).

To be successful, the new service design should cover: assessing the original service systems (process, physical facilities, and participants) and evaluating existing customers; assessing the new service concept from a market perspective; assessing the new service

design regarding processes, physical facilities and participants; assessing the impact of integrating the original and new service systems; and finally, assessing the capability and strategic options to implement the change (Tax & Stuart, 1997).

Being successful in new service design brings superior customer value for the service providing company related to its competitors, and this is seen as a great differentiator factor in the market (Matthyssens & Vandenbempt, 1998). The criticality of technical expertize and relationship between the customer and the service provider is even more strongly emphasized for competitive advantage.

2.3.4 Strategic approach to bringing competitive advantage

In order to achieve the three key factors (service quality, total solution, and innovative service design) that bring competitive advantage in industrial services, companies need to invest in assets, unique skills, and culture, organization and human resource management (HRM) (Matthyssens & Vandenbempt, 1998; see Figure 3.).

Investments in structural *assets* such as IT, infrastructure, and quality equipment, enhance service efficiency and productivity (Matthyssens & Vandenbempt, 1998; Kowalkowski, 2008). Integrated information systems create cost-savings and enhance informed decision-making based on accurate and up-to-date data (Tsang, 2002), and improve service productivity (Kowalkowski, 2008). Service management systems should support modeling, documentation, presenting performance results, and possibly linking to partners' software systems (Tsang, 2002). Performance tracking systems usually focus on equipment, cost, and process performance measures. However, Tsang (2002) recommends including the Balanced Scorecard (Kaplan & Norton, 1996) of strategic measures considering financial, customer, internal processes, and learning and growth perspectives.

Developing company core competences and harmonizing multiple technology integration in companies lead to having *unique skills* (Hamel & Prahalad, 1990; Matthyssens & Vandenbempt, 1998). Technical, relationship, and project and marketing skills of service personnel are identified as critical service capabilities (Matthyssens & Vandenbempt, 1998). As the service offering becomes more focused on service that actually supports customer's actions, the people involved in providing the service become the main asset in creating competitive advantage in industrial services (Mathieu, 2001). Therefore, focus should be given to recruitment and selection of the personnel, and to training the personnel in effective customer service (Bowen et al., 1989; Boyt & Harvey, 1997).

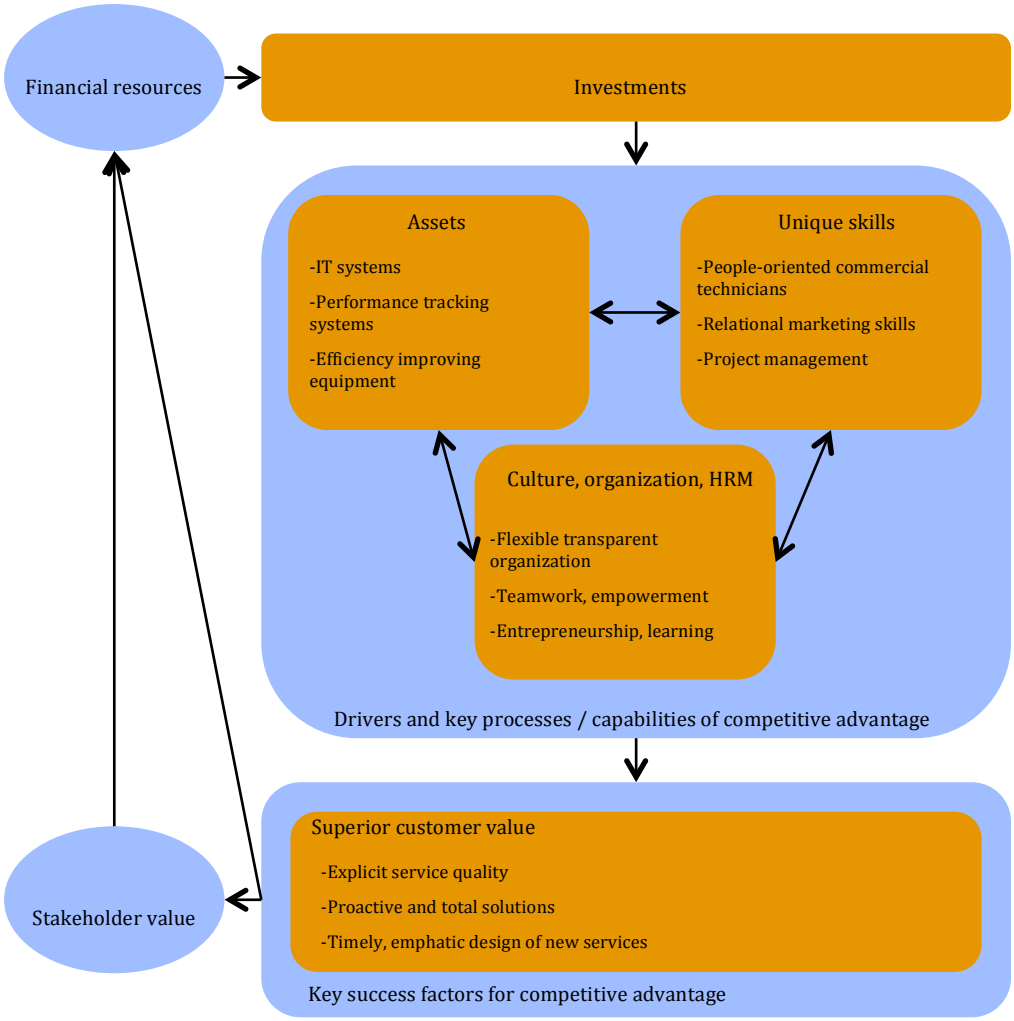


Figure 3. Competitive advantage drivers and key success factors in industrial services (adapted from Matthyssens & Vandenbempt, 1998)

Finally, focus on company's *culture, organization and HRM* is required to drive the creation of competitive advantage. These factors create organization flexibility, transparency, team selling approach in the eyes of customer, and organizational learning (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998). Values, management behavior, and support systems of information, training, performance management, and rewarding need to be in place (Tsang, 2002). According to Tsang (2002), company's decisions here should focus on following issues:

- employee empowerment through participating and leveraging autonomy;
- recognizing the effects of evolutionary psychology on people behavior, hierarchy and communication (i.e. people focus on bad news, people avoid risks in comfort zone and take risks when dissatisfied, informal communication networks exist and are rapid, etc.);

- training and education should be accessible and not limited to technical skills and knowledge needed for optimal task performance;
- finding suitable rewards and recognition methods e.g. bonuses, performance awards, certificate of appreciation, and providing one-shot responsibilities, while recognizing the force of trust, involvement and autonomy as human drivers.

"Excellence in these KSFs [key success factors of service quality, total solutions, and service design] and drivers [assets, unique skills, and culture, organization and HRM] seem to suggest good performance in present business service markets and a high delivered customer value which eventually will result in shareholder value" (Matthyssens & Vandenbempt, 1998). On the other hand, if focus is not given to managing and maintaining intangible assets and service capabilities of the company, then operating costs will increase and performance lower (Repenning et al., 2001), and potential competitive advantage will be lost.

To summarize the issues discussed in this chapter, it can be said, that servitization of manufacturing is happening, but it is nevertheless challenging for manufacturing companies to adopt service approach of business and relationships with the customer. Challenges that manufacturing companies are facing relate to especially marketing and productization, and production and delivery of services. These challenges are relevant as they are strongly linked to gaining competitive advantage that is created through excellency in the service quality, total solutions offering, and innovating new services in collaboration with the customer. Hence, organizational and cultural change is required, where focus is on investments in organization's key processes and capabilities - that is company's assets, unique skills, and culture, organization and HRM. Above all, human factors and information flow seem to be exceptionally critical aspects for the success in services (Tsang, 2002), as customers perceive service quality through intangible determinants and service personnel attributes.

3. MAINTENANCE SERVICE AND FIELD SERVICE ENGINEER (FSE) COMPETENCE

As the interest in this study is on field service engineers (FSE) working in industrial maintenance services, the emphasis in this chapter will be on maintenance services and maintenance work, and the requirements of personnel competence. Individual's competence is a complex combination of knowledge, skills and attitudes (Baartman et al., 2006) and describes individual's capacity to successfully handle a situation or perform a task according to some preset (explicit) criteria (Ellström & Kock, 2008).

Therefore, this chapter provides an overview from literature on the maintenance service offering and approaches, the organizing of maintenance services, the service delivery and work of the service personnel, and finally, the requirements resulting from the maintenance work requirements on FSE competence.

3.1 Maintenance service offering

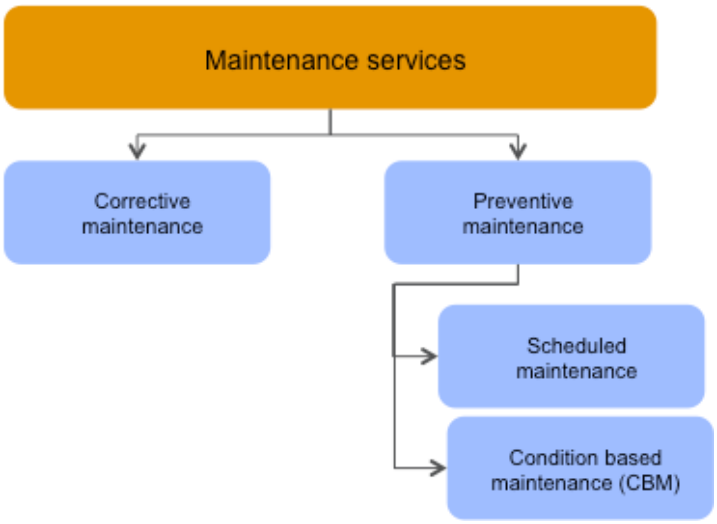


Figure 4. Maintenance services approaches (based on Tsang, 1995; Tsang, 2002; Kumar & Kumar, 2004; Ruiz, 2006; Ala-Risku, 2009)

Product and plant availability is an important factor in customer's operation, and customer's products and plants need to "receive primary care, which includes routine servicing such as cleaning, fuelling and lubricating, as well as periodic inspection and

calibration" (Tsang, 2002). A common categorization of maintenance activities comprises two main types of maintenance: corrective maintenance and preventive maintenance (Tsang, 1995; Tsang, 2002; Kumar & Kumar, 2004; Ruiz et al., 2006; Ala-Risku, 2009; see Figure 4.). Corrective maintenance and predictive maintenance strategies are discussed in the following sub-chapters.

3.1.1 Corrective maintenance

Corrective maintenance is reactive in nature, and describes the type of maintenance for unscheduled or unpredicted equipment failure. Maintenance costs in corrective maintenance are usually higher and therefore, this type of approach to maintenance should not be the driver for the maintenance policy in a manufacturing company providing services (Tsang, 1995). However, run-to failure type of corrective maintenance service is performed on items that in case of failure have inconsequential impact in operation or failure preventive investments in service are not worth (Tsang, 2002).

Nevertheless, in general, corrective maintenance is expensive and unfavorable approach. From the customer point of view, the most important issues related to maintenance services for customer's industrial products include equipment availability, overall equipment effectiveness and reliability. Unexpected failure and equipment downtime create costs from production loss, lower quality, and unused resources. (Ala-Risku, 2009)

3.1.2 Preventive maintenance

Preventive maintenance is performed on equipment while it is still operating, and aims to keep the equipment "at the desired level of operation" (Ruiz et al., 2006). Preferably, the focus in maintenance offering should be on preventive maintenance that targets to prevent failure, detect the onset of failure and hidden failure (Tsang, 1995; Ruiz et al., 2006). This type of approach controls more the costs for maintenance and increases customer satisfaction as equipment failure rates decrease (Tsang, 1995). Furthermore, Ruiz et al. (2006) list objectives of preventive maintenance that include: increased equipment reliability that reduces failures in operation and costs, as well as improves equipment availability; increased equipment operational life time; improved production planning; and finally, ensured safety.

Preventive maintenance can be both scheduled overhauls and part replacements (Ruiz et al., 2006), or predicted condition based maintenance (CBM) (Tsang, 1995; Ala-Risku, 2009). Scheduled (or time directed) maintenance is one approach in preventive maintenance. However, it can comprise a lot of unnecessary tasks and waste of resources. This is because scheduled maintenance is performed in intervals and based on preplanned

estimations on equipment and equipment lifecycle. Additionally, fault-finding tasks for revealing hidden failures are performed as scheduled maintenance. These tasks are performed on equipment such as standby units or devices that are not often used but critical in case of sudden failure. (Tsang, 1995)

Condition based maintenance (CBM) on the other hand focuses on equipment usage or condition monitoring, and without risky intrusions into the equipment. CBM is recommended when equipment failures occur randomly and a measurable parameter and parameter limit value indicating failure onset can be identified. In CBM, parameters such as vibration and noise levels, particles and chemicals released into the environment, cracks and wear, temperature rise, resistance and conductivity etc. can be monitored. (Tsang, 1995)

Tsang (2002) further adds design improvement as one approach to item maintenance, where the item's original design is being modified. This type of activity targets to improve the reliability and maintainability, and to minimize the maintenance resource requirements and the need for regular service.

3.2 Organizing maintenance service

Unlike in manufacturing, the supply chain for maintenance services requires a more complex infrastructure. Organizational strategy must support efficient service delivery through a service network of parts, people and equipment in huge amount of locations, and often globally (Cohen et al., 2006). Service delivery requires material and trained service personnel in dispersed locations, and adaptability to unexpected service demands (Cohen et al., 2006). However, the practical changes in servitizing are not enough, and a change in the company mindset, practices and attitudes is a necessity. Hence, for one, focus on company people and understanding them being the main asset in providing services is highly critical (Baines et al., 2008).

In addition, industrial maintenance services are also affected by emerging operation strategies, increasing expectations on companies environmental and safety promoting activities, increasing technical standards, increasing prices, technological changes, and changes in the organizational systems and people and their attitudes towards work. These issues are creating challenging demands for industrial maintenance operations and maintenance performance. (Matthyssens &Vandenbempt, 1998; Tsang, 2002)

In this challenging environment for maintenance services, the strategic planning for the resources (engineers and spare parts), and for the service delivery process are critical factors (Ala-Risku, 2009). These are reviewed based on literature in the following.

3.2.1 Maintenance work structuring and resources

According to Tsang (2002) strategic options in maintenance work organizing and work structuring are to flatten the hierarchy, develop a flexible workforce, and maintain a specialized workforce. Key decision areas regarding those strategic options are plant specialization, workforce location, workforce specialization, structuring of maintenance work, and interface with operations.

Maintenance service can be plant-flexible or plant-specialized. Plant-flexible maintenance focuses on workforce that is servicing several customer sites with more equipment/item focus in knowledge and skills. This promotes labor mobility. On the other hand, plant-flexible maintenance approach results in improved work quality and faster response to service demands. Plant-specialized workforce has more comprehensive understanding on customer operations and knowledge and skills for customer's specific maintenance needs. However, in that case lower labor utilization may cause problems. (Tsang, 2002)

Strategic planning for engineers is critical, and this should comprise a plan for the amount of engineers required, and a plan for the allocation of the engineers to service areas (Ala-Risku, 2009). Workforce location should be decided based on maintenance work type and plant specialization approach. Plant-flexible workforce is usually located centrally, and plant-specialized workforce dispersed close to customer. Industrial maintenance service providers face the challenge of geographically dispersed customer site locations. According to Kumar & Kumar (2004), the geographical location challenges the service delivery as different communicational styles, regional cultures, local rules and regulations, such as permissions and taxation, are present. These issues concern companies that provide services globally, and affect the requirements for service capabilities and stress the importance of the resources delivering the service.

Companies should deploy multi-purpose resources. Technical cross-training of field service engineers (FSE) is proven beneficial (up to 50% of all FSE) (Colen & Lambrecht, 2013), and cross-training for the FSE secondary skills can increase flexibility and back-up availability for the service, and provide savings in resources (Ala-Risku, 2009). Nevertheless, cross-training is time-consuming and expensive as investments in training and organizing is required (Tsang, 2002).

Maintenance work structuring is supported by grouping the maintenance tasks. This grouping is decided based on how strong interrelations the maintenance tasks have regarding the used technology and the used information, interaction between tasks, and interconnectedness between tasks. This kind of maintenance work structuring further

guides what knowledge and skills a single FSE or a workforce group should embody and "ensures the long-term training and career paths of the respective engineers and technicians" (Tsang, 2002).

Interface between the maintenance and operations need to be considered, even if maintenance service is the focus of delivery. Whether customer's operations consider maintenance for reliable and stable technology, or for insecure and evolving technology, this affects the level of involvement and integration between maintenance and operation, and the skills required from the FSE. (Tsang, 2002)

3.2.2 Maintenance service process

Maintenance service customers recognize maintenance service as a process (Kutvonen, 2012; see Figure 5.). This descriptive process is used here to discuss the maintenance service work requirements on the FSE during the service delivery and being in contact with the customer.

Figure 5. Maintenance service process (based on Kutvonen, 2012)

Service preparation phase. To meet the customer's needs and optimize own costs from providing maintenance services, the service providing company should have their main focus in the service process on problem evaluation when trying to find suitable skilled engineers and spare parts for a certain service demand. According to Ala-Risku (2009), strategic planning for maintenance services should comprise a plan for customer call procedures. When the service call from the customer is received, the problem evaluation should be effective in order to define what kind of service (engineer, spare parts) is needed, or could the customer possibly be supported from distance.

This includes taking into account the location information, equipment criticality, access constrains on customer site, equipment skilled engineers, and equipment service history (Ala-Risku, 2009). Often, the customer may also require the FSE to participate in a customer's own specific site safety and practice trainings prior to the actual service delivery (Kutvonen, 2012). Finally, the dedicated FSE may contact the customer regarding

the further mapping of service and spare part needs, of any unexpected issues, and about confirming on upcoming arrival (Kutvonen, 2012).

Field service phase. This is the actual service production and delivery phase comprising FSE's arrival to the customer's site, servicing the equipment or item, and informing completion or status for the work prior leaving. The maintenance work on equipment can be performed by the FSE alone, or in collaboration with the customer's site personnel. Upon the arrival, and also when informing the customer on performed maintenance, the FSE has informal and formal communication with the customer on both work and non-work related issues (Kutvonen, 2012). In addition, during the field service phase in general, it is very important for the customer, that the FSE adopts and obeys the health and safety regulations on customer's site (Kutvonen, 2012).

Follow-up phase. For the final phase of the service delivery, the documentation and report from the service is delivered to the customer. This comprises information on performed maintenance work, possible recommendation and suggestions on future maintenance or spare parts, answers to possible questions by the customer, etc. The FSE might also give final check-up calls for the customer (Kutvonen, 2012).

3.3 Field service engineer (FSE) competence requirements

Nguyen (1998) reports based on her survey on essential skills and attributes of FSE that both technical and non-technical competences for FSE are required. The survey suggested that the technical knowledge and skills, and the attitudes are the most important for FSE to possess. Regarding the attitudes, the FSE should be committed to their organization and have integrity while practicing their work (Nguyen, 1998). In general, the value of FSE's relational skills is emphasized in research (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Mathieu, 2001).

Requirements for FSE competence based on literature comprised technical competence and soft (or relational) skills, yet other skills requirements were mentioned as well:

Technical competence. FSE is required to have technical skills and knowledge needed for optimal task performance (Tsang, 2002). Technical skills and knowledge comprised science and engineering fundamentals, and engineering practices (Nguyen, 1998). Also profound competence to handle the equipment is critical (Kutvonen, 2012). According to the customers, the FSEs need to be competent enough so that they are capable to work independently and successfully on site (Kutvonen, 2012).

Soft skills. In Nguyen's study (1998), the industry placed much importance on engineer's communication skills within their organization and community. Similarly, clear communication skills were emphasized in Kutvonen's study (2012), and customers valued especially informal, straightforward and open-minded approach in communication between the service person and the customer. Also, short reaction times to get the support and service, prompt arrival on site, finishing the service work within one day, and communicating problems to the customer were perceived as good service attributes for the FSE. The FSE attributes of reliability, responsiveness, empathy, communication, and credibility affect how the customer perceives the service quality (as was discussed in chapter 2.3.1). Hence, emphasis on the FSE's soft (or relational) skills – the skills that are not related to technical competence but on how the FSE behaves and operates within an organization (Nguyen, 1998) – is important when looking at the FSE competence requirements.

Other skills. Other highly ranked engineer skills and attributes include having competence in understanding and applying environmental constraints, quality control, technical terminology, and economic and political issues (Nguyen, 1998). The customer also wants the FSE to follow health and safety regulations (Bowen et al., 1989; Kutvonen, 2012). Tsang (2002) further adds that training for the FSE should also cover product and service value factors to customers, problem-solving techniques, team dynamics, and facilitation skills.

Table 2. concludes the FSE competence requirements, on a very general level, identified from literature. However, it should be noted here that very little research and literature on service engineers' and technicians' actual work requirements, competence or qualification requirements were found.

Table 2. Field service engineer (FSE) competence requirements (based on Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Nguyen, 1998; Tsang, 2002; Peterson et al., 2004; Kutvonen, 2012)

CATEGORY	COMPETENCE	
Technical competence	Science and engineering fundamentals	Nguyen, 1998
	Engineering practices	Nguyen, 1998
	Profound competence to handle equipment and maintain	Kutvonen, 2012
	Capable to work independently on site	Kutvonen, 2012
Soft skills (or relational skills)	Reliability	Bowen et al., 1989; Nguyen, 1998; Matthyssens & Vandenbempt, 1998; Peterson et al., 2004; Kutvonen, 2012
	Responsiveness	
	Empathy	
	Clear communication skills	
	Credibility	
Other skills	Understanding and applying environmental constraints	Nguyen, 1998
	Understanding and applying quality control	Nguyen, 1998
	Understanding and applying technical terminology	Nguyen, 1998
	Understanding and applying economic and political issues	Nguyen, 1998
	Understanding and applying health and safety acts	Bowen et al., 1989; Kutvonen, 2012
	Understanding product and service value to customer	Tsang, 2002
	Problem-solving techniques	Tsang, 2002
	Team dynamics	Tsang, 2002
	Facilitation skills	Tsang, 2002

To summarize the issues discussed in this chapter, it can be said that in successful industrial maintenance services the skilled FSE is a requirement as they are the ones who deliver the service. Therefore, there should be enough service engineers, with appropriate knowledge and skills, and training provided for them (Ala-Risku, 2009). Maintenance work structuring and decisions on workforce characteristics, as well as the maintenance service process further set requirements for the FSE's competence. Based on the work structuring, the workforce development can focus on developing either plant-flexible or plant-specialized FSEs, or both, and can choose to promote cross-training to increase the workforce flexibility. The service process, on the other hand, stresses the importance of FSE's technical competence and interpersonal skills, as essential FSE factors important to the customer (Kutvonen, 2012). Nevertheless, very little research and literature on service engineers' or technicians' actual work requirements, competence or qualification requirements were found.

4. MANAGING PERSONNEL COMPETENCES

The research problem concerns field service engineer's (FSE's) competence and how to assure that competence. This chapter reviews existing managing practices for the personnel competence in companies. First, competence as a concept is defined and then, competence management as an emerged field of importance in companies is briefly reviewed. This will follow discussion on intellectual capital (IC) and prevailing management models. Finally, actual competence development practices in companies are analyzed based on the available literature.

4.1 Defining competence

The term competence is widely used but no clear definition seems to exist. On an organizational level, Hamel & Prahalad (1994) define competence as a bundle of skills and technologies that enhance companies' generation of benefits to customers. Similarly Drejer (2000) refers to competencies as interactions between people, technology, organizational structure and organizational culture.

However, in this study, the term competence is discussed more on the individual level and thus, competence is defined as: individual's capacity to successfully handle a situation or perform a task according to some preset (explicit) criteria (Ellström & Kock, 2008). According to Ellström & Kock (2008) individual's competence comprises perceptual motor skills, cognitive factors, affective factors, personality traits and social skills.

Looking from the point of view of developing competencies, according to Biggs (2003, p.42), competence is something to be acquired developing through levels of acquiring first knowledge, then skills, and finally competence: knowledge is the first level presenting declarative type of knowledge, skills is the second level presenting procedural type of knowledge, and competence is the third level presenting conditional type of knowledge.

Baartman et al. (2006) further adds that attitudes affect competence, and define that competence is a complex combination of knowledge, skills and attitudes. Similarly, Bergenhenegouwen et al. (1996) divide individual's competence into "expertize and skills", and into "individual competences". Individual competences concern the fundamental personality characteristics where the underlying motives and qualities of the employees affect individual's actions (Bergenhenegouwen et al., 1996). These underlying

characteristics are very difficult to train, unlike knowledge and skills. Therefore, individual's underlying characteristics should be considered already in the selection and recruiting phase (Bergenhenegouwen et al., 1996).

4.2 Brief introduction to competence management

Increasing focus on services, faster pace of business, competitive pressure, customer demands, need for ability to anticipate competence requirements and build competences faster has led companies to focus more on their individual employee's skills and knowledge. This is affecting the competency practices in companies (Athey & Orth, 1999; Robertson, 1999; Ellström & Kock, 2008). Additionally, conditions such as companies' learning culture and leadership style lead companies to pursue competence development (Ellström & Kock, 2008). Another aspect to competence development is also political such as insufficient opportunities for education and on-the-job learning that further lead to wider education gaps in society (Ellström & Kock, 2008).

Company operations have become increasingly dependent on knowledge and the intangible assets (e.g. people) possessing it, hence focus on new ways of managing the company capital has been required. Intangible assets (or often referred to as intellectual capital as well) affect value creation and economic performance of companies (Petty & Guthrie, 2000), as companies' market value is created from the sum of financial capital (financial and physical assets), and intellectual capital. Intellectual capital is the assets created through intellectual activities such as learning, creating valuable relationships etc. (Wiig, 1997).

Intellectual capital (IC) management field has developed around the need to manage company intangible assets i.e. to improve the measuring and reporting of those assets of the company. IC models provide strategic architecture for managing and developing company's intangible assets and individual competences. "Gaining access to the power of a firm's human resource often means knowing what piece of information or knowledge is relevant, which employee has it, and the speed with which the knowledge can be shared" (Edvinsson & Sullivan, 1996).

Hence, management strategies provide support, and structures are needed (Suikki et al., 2006). The development of the IC management field has created new opportunities for companies' competency practices including utilization of information systems in managing competency development, using competences as a mean to bring visibility to company strategy and values, and reengineering HR roles (Athey & Orth, 1999; Suikki et al., 2006;

De Vos et al., 2011). Nevertheless, clear understanding of competence and of how to manage and develop it is still somewhat missing (Otala, 2008, p.37).

Other challenges for IC management field include external demanding requirements, globalization, and missing measurement. Additionally, quality standards are more and more common and required, and they all highlight the importance of competence and managing it (Otala, 2008, p.43). According to Otala (2008, p.81), the competence and IC needs to be visible in the company, the responsibilities and targets need to be clear, and the measurement must be in place. Data collection is important, and processes and tools is a requirement for IC management as well (Otala, 2008, p.94).

4.3 Intellectual capital (IC) management

As it was discussed in chapter 2.3.4, the intangible assets (assets, unique skills, and culture, organization and HRM) function as drivers for competitive advantage in industrial services. The existence of intangible assets is not enough, but these capabilities need to be leveraged into superior customer value (Matthyssens & Vandenbempt, 1998). Leveraging intangible assets is the key to creating better company performance. Hence, unique skills (Matthyssens & Vandenbempt, 1998) such as the FSE competences, are related to company performance, but cannot lead to better company performance by itself (Rompho & Siengthai, 2012).

Therefore, a strategic architecture for competence building (guidance for ideas, innovations in infrastructure, and theory, methods and tools) should be made (Prahalad & Hamel, 1990; Suikki et al., 2006). Intellectual capital classification and management models are reviewed in the following sub-chapters. Various classifications and models have been developed mainly to improve the measuring and reporting on intellectual capital in companies (Petty & Guthrie, 2000).

4.3.1 IC classification

Definitions of intellectual capital (IC) vary and no explicit classification seems to exist. Also companies prefer approaching IC from their own perspective and therefore focus of IC management varies (Edvinsson & Sullivan, 1996). However, commonly IC (or intangible assets) is described as something invisible, non-monetary asset, intangible/asset without physical substance, a dynamic asset, and something that can be transformed into value (profit) (Suikki et al., 2006; Choong, 2008; Otala, 2008, p.58). IC includes both recorded information and non-codified human talent or knowledge (Dalkir, 2005, p.335).

Prevalent classification of IC comprises three categories, namely human capital, structural capital, and relational (or customer) capital based on Sveiby's (1997) work (Petty & Guthrie, 2000; Choong, 2008; Otala, 2008, p.57; Brunold & Durst, 2012; see Figure 6.). These three categories all interact and knowledge is transferred to create value for the company (Sveiby, 2001; Dalkir, 2005, p.315).

Human capital, recognized as the key component of IC (Petty & Guthrie, 2000; Rompho & Siengthai, 2012), consists of employees, and their background, competence, motivation and engagement to the company. Companies develop their human capital through investing in human resource development activities on individual and organizational (organizational learning) levels (Rompho & Siengthai, 2012).

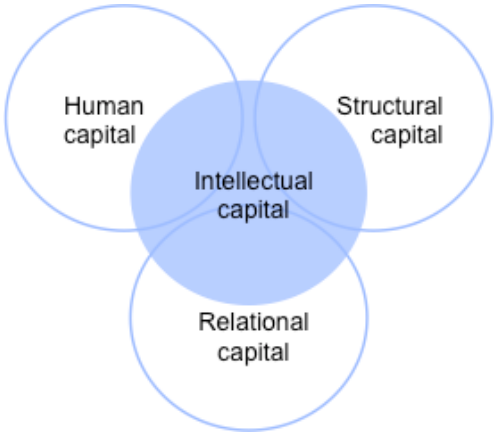


Figure 6. Intellectual capital (adapted from Sveiby, 1997)

However, company cannot own its human resources, but it can own all structural assets such as IT (information technology), infrastructure, codified knowledge and IP/IPR (intellectual property; brands and rights). From the company point of view, the intangible IC should be transformed into tangible to make sure that critical assets become company property, and are not lost. The way to gain some power over the company's human resources is to have codified knowledge (data) on what knowledge is relevant, which employee has this knowledge, and how this knowledge can be shared (Edvinsson & Sullivan, 1996).

"Structural capital is the infrastructure that firms develop to commercialize their human capital" (Edvinsson & Sullivan, 1996). This infrastructure includes direct support for performing work such as computers, information systems, work procedures, company know-how, etc., and indirect support such as office and supplies, payrolls, costing

structures, supplier relationships etc. Therefore, the structural capital enables companies to manage and utilize employee skills and knowledge in a way profitable for the company (Otala, 2008, p.62). Organization, its culture and values are part of structural capital as well (Otala, 2008, p.62).

Relational capital comprehends company's customers, partners, other stakeholders and networks (Sveiby, 1997), and describes the strength of company's relationships with these stakeholders from structural point of view (Dalkir, 2005, p.315). The relational capital as external structure of IC provides structures for communication and knowledge transfer between the company and its outer world (Sveiby, 2001).

Nevertheless, the content and terms used for the human, structural, and relational capital categories vary, and thus IC classification has often been judged as too qualitative, broad and unclear (Choong, 2008).

4.3.2 IC management models

There seems to be few IC management trends that have reached more popularity than others. These include Sveiby's (1997) Intangible Asset Monitor emphasizing the importance of information (on growth, renewal, efficiency, stability, risk) related to intangibles; Kaplan & Norton's (1996) Balanced Scorecard promoting a holistic company performance measurement system supporting the transformation of company's vision and strategy into operations and successful performance; and Edvinsson & Malone's (Edvinsson, 1997; Edvinsson & Malone, 1997) Skandia Value scheme combining both Sveiby's model and the Balanced Scorecard focusing on transforming human capital into structural capital. (Petty & Guthrie, 2000; Dalkir, 2005, p.275, 316; Choong, 2008)

Otala (2008, p.87) provides a description of IC management process, one in many ways compliant with the Intangible Asset Monitor and Skandia Value scheme models. This description focuses on approaching the IC management from the competence point of view. Otala's (2008) process is illustrated in Figure 7., and consists of the IC strategy development process and the strategy implementation.

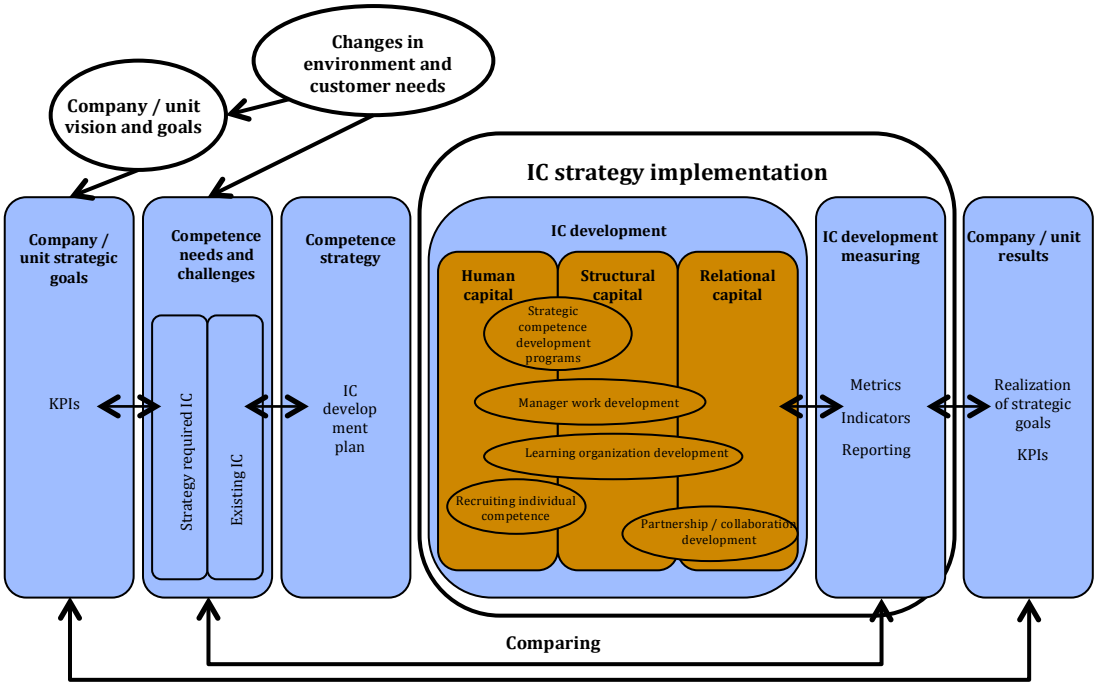


Figure 7. Intellectual capital (IC) management model (adapted from Otala, 2008, p.87)

First, the business goals reflecting environmental and customer demand should be identified. Related to the vision and goals the existing competences should be mapped and the competence gap identified. Continuing the strategy process a competence strategy and plan specifying responsibilities, critical competences, partners, and IT strategy is developed.

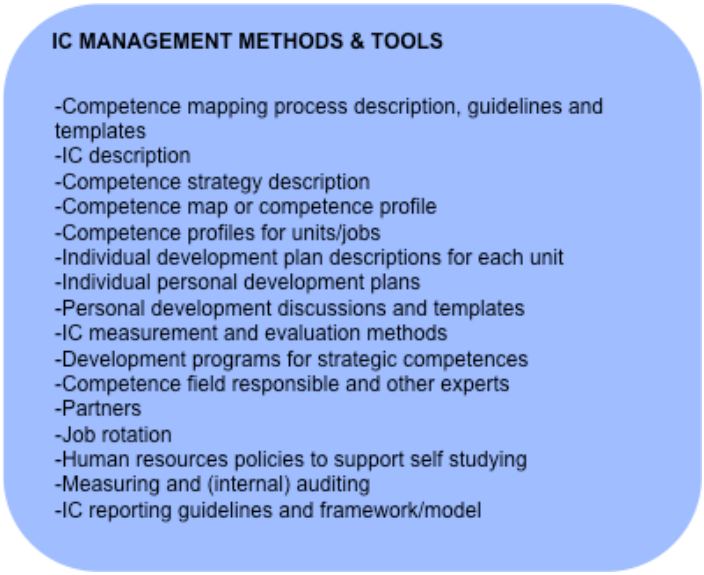
In the IC strategy implementation phase the plan takes place in the form of different development programs and projects such as the examples presented in the Figure 7. These activities are usually related to more than one IC category and present structural capital of the company. This supporting infrastructure is a requirement for the human capital development (Rompho & Siengthai, 2012).

Finally, the results need to be measured to see how the goals were achieved and what future activities need to be considered. The KPI's (key performance indicators) will indicate in the end how the company or unit strategic goals were realized.

To conclude, the IC management process is realized through various IC development programs and projects for the human capital, structural capital and relational capital. Hence, strategy driven company competences are developed through competence

development programs to meet the business competence needs. Otala (2008, p.92) further listed methods and tools used in the IC management in companies (see Table 3.).

Table 3. Methods and tools for IC management (adapted from Otala, 2008, p.92)



4.4 Competence development practices in companies

Drejer (2000) defines competence development as a learning process for improving performance by learning to do a task even better. Through a learning process changes in competence (knowledge, skills, and attitudes) takes place. Competence development activities in a workplace can emerge formally or informally, both on individual and organization levels (Ellström & Kock, 2008, see Table 4.).

Individual level strategies include theoretical school model approaches and on-the-job training. De Vos et al. (2011) add one more dimension to individual level competence development strategies, namely career management. Organization level strategies comprise in-service training and continuing education, as well as informal organizational learning and development. Dimensions and several activities are usually combined as a preferred approach (Ellström & Kock, 2008; De Vos et al., 2011). Further, personnel education can be seen as a control mechanism to adapt employees to the organization or as an instrument to increase the interest and preparedness for further learning (Ellström & Kock, 2008). Nevertheless, competence development is said to sometimes take place in companies through non-strategic, reactive and ad hoc activities, as a result of impressions of competence development being "in fashion", or as a vehicle for marketing purposes (Ellström & Kock, 2008).

Table 4. Competence development activities (based on Ellström & Kock, 2008; and De Vos et al., 2011)

DIMENSION:	INDIVIDUAL	ORGANIZATION
Curriculum based (formal)	School model	In-service training Continuing training
Practice based (informal)	On-the-job training (informal learning in work)	Organizational learning and development
Career management	Career counselling Career paths	

At best the competence development practices lead to: positive selection and mobility in the internal labor market, socializing and social control of employees, legitimization of goals and decisions, improved decision making ability in the organization, development of participative decision making and work environment, development of the organization readiness for change, and better motivation and learning environment (Ellström & Kock, 2008). However, research on competence development is criticized for not been able to follow the actual progression in practices taking place in companies (De Vos et al., 2011).

The following sub-chapters discuss first the individual learning in company context, then present the affecting factors that make for successful competence development program, and finally, the competence development programs and characteristics are discussed through the three stages of competence development.

4.4.1 Individual learning in workplaces

Individual learning can occur in various ways. Learning can occur unconsciously or consciously. Unconscious learning is based on a behavioristic learning approach, where an individual is seen as a passive learner, and where the environment, and rewards and punishments affect the learning. Conscious learning is based on a constructive learning approach, where the learning is a result from individual's needs that create motivation for the learning. Furthermore, the constructive learning approach reviews an individual as an active learner. This latter learning approach is more common in today's world (Otala, 2008, p.65).

In a workplace, learning can occur as repetitive, reflective or creative in type depending on the purpose or need for competence development (Otala, 2008, p.72). However, each person is an individual learner whose natural way of learning varies. Therefore, different

approaches to learning process need to be regarded. Kolb's (1984) experiential learning model developed for examining the individual's learning process is widely in use (Drejer, 2000; Suikki et al., 2006; Otala, 2008, p.68). Individual experiential learning occurs from a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Kolb's learning cycle illustrates that one full cycle is required for actually learning something (see Figure 8.).

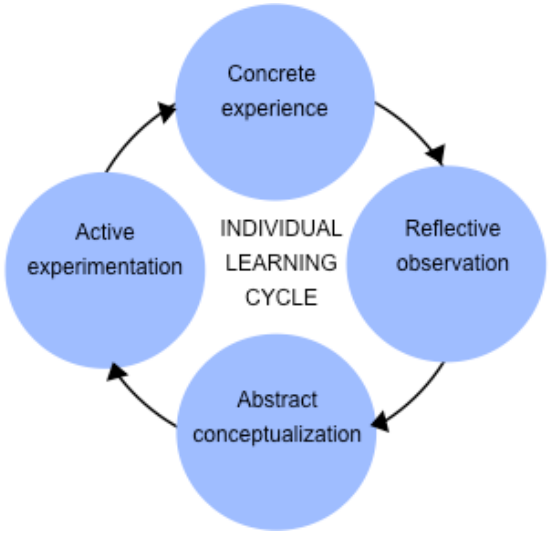


Figure 8. Kolb's learning cycle (based on Drejer, 2000; Suikki et al., 2006; Otala, 2008, p.68)

Learning can occur as formal, informal, or incidental learning. However, formal learning of individuals is minimal, and the importance of informal learning and of tacit knowledge – knowledge and competence accumulated through experience - is emphasized (Drejer, 2000). According to Dryden & Vos (1996), individuals learn only 10% through reading, 15% through hearing, and as much as 80% from experience (Otala, 2008, p.68). According to Drejer (2000), the individual growth process of learning about oneself and from the feedback of others, reflection on learning, and making changes is based on feedback and self-disclosure. Important notion is also that individuals learn by being open to others.

In a workplace, individual's (employee's) learning and competence is improved by both formal training and informal on-the-job training (Ellström & Kock, 2008; Rompho & Siengthai, 2012). Work and practice are referred to as the best way to learn. In many companies learning activities are divided into 20% of training and education, 30% of socializing and networking, and 50% of learning from working (Otala, 2008, p.69).

4.4.2 Factors affecting successful competence development

Competence development programs, where the interaction between four (4) affecting factors – individual's prior experience on training and education, competence development program factors, and company's context conditions i.e. internal and external factors - are considered, seem to be more successful (Ellström & Kock, 2008; see Figure 9.).

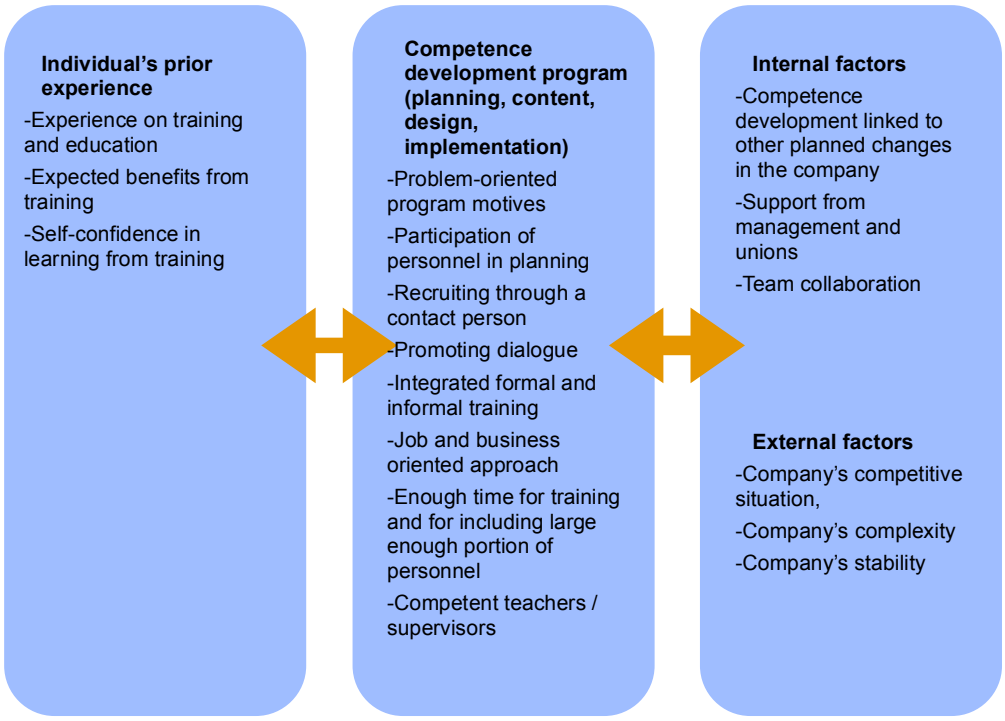


Figure 9. Affecting factors for successful competence development (based on Ellström & Kock, 2008)

Firstly, individuals' motivation, attitudes, and willingness to participate in training reflect their previous experiences on gained knowledge and skills, gained benefits, and self-confidence in being able to learn and develop through training. Motivation can occur on different dimensions, namely extrinsic motivation, social motivation, achievement motivation, and intrinsic motivation. Extrinsic motivation drives learning according to presumed benefits, social motivation results from the value of learning assumingly created by others, and achievement motivation exists in a competitive environment. However, intrinsic motivation is the most powerful dimension of motivation driving deep learning resulting from pure interest and pleasure for learning (Biggs, 2003, p.61). The role of teachers and teaching methods (Biggs, 2003, p.64), and involving individuals in the competence development initiatives are said to enhance the individual competence

development results greatly (Biggs, 2003, p.61; De Vos et al., 2011; Rompho & Siengthai, 2012). These issues should be carefully observed and considered in the competence development program planning, content, design, and implementation.

Competence development program motives should be problem-oriented, personnel should be involved in the planning at least on some level, recruiting of participants to the program should be through a contact person to support feeling safe, and dialogue and individual approach should be promoted especially as the starting point for a participant taking up for training. Additionally, the program focus should be about widening or deepening of personnel job related competence rather than having an individual approach to competence development. Also, enough time should be scheduled for the program, and competent trainers and supervisors need to be available. (Ellström & Kock, 2008)

However, developing competences must consider the whole business context of the company, both internally and externally. Internal factors should consider other planned changes for the company and aligning competence development with those, positive support from management and unions, and collaborative activities within teams (Ellström & Kock, 2008). Positive organizational culture and positive culture for learning that can comprehend open work environment for sharing tacit knowledge, appropriate work space, encouraging learning environment, valuing of positive attitudes, valuing of diversity, diverse learning opportunities, and support for learning and development, add to successful competence development (Otala, 2008, p279; De Vos et al., 2011).

External factors include company's competitiveness in the market, the complexity (and size), and stability of the company (Ellström & Kock, 2008). In addition, De Vos et al. (2011) recommend considering following affecting external factors such as "legislative, governmental, and political context, the social and economical factors and the conditions of the labor market". It should be noted that the interplay between individual attitudes, the competence development program, and the company's context takes place and affects the success from the investment on competence development. According to Ellström & Kock (2008), the competence development activities can enhance organizational learning resulting in enhanced competence development climate; enhance solidarity and positive organizational culture.

4.4.3 Competence development program

Bergenhenegouwen et al. (1997) present the cycle of competence development program comprising three (3) stages; determining competences, developing competences, and monitoring the effects of competence development (see Figure 10.).

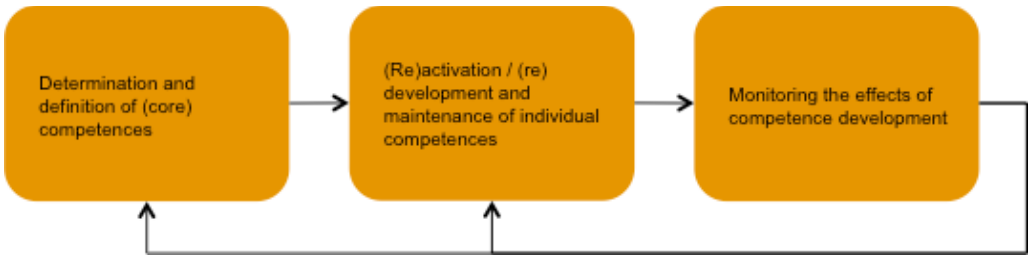


Figure 10. Cycle of competence development (adapted from Bergenhenegouwen et al., 1997)

Determination and definition of competences

According to Bergenhenegouwen et al. (1997), a company must have "a set of instruments" (structures) in place prior the competence development activities can be approached. The actual competence development should start from first identifying and describing the (core) competences, and further developing the competence development program(s). These activities in companies often include e.g. conducting competence mapping, creating competence profiles for units/jobs, creating individual development plan descriptions for unit(s), and creating individual personal development plans (Otala, 2008, p.92; see chapter 4.3.2 Table 3.).

Competence development models in company contexts seem to have adapted a 5-level approach for defining individual's competence (Drejer, 2000; Otala, 2008, p.124). These five levels are novice, advanced beginner, proficient, expert, and world class. From the academic education field, there are similar five (5) stages that occur in student's learning (Biggs, 2003, p.38). The SOLO (Structure of the Observed Learning Outcome) taxonomy levels (Biggs & Collis, 1982) describe the outcome from learning, as the structural complexity of the topic to be learned increases through first learning being quantitative and then qualitative (Biggs, 2003, p.38).

The SOLO levels are not named as in the company contexts levels by Drejer (2000) and Otala (2008), but they as well describe the different levels of individual's competence: prestructural knowledge, unistructural knowledge, multistructural knowledge, relational knowledge, and extended abstract knowledge (Biggs, 2003, p.39). On the first two SOLO

levels, competence development is more concentrated on quantitative change that is increasing the amount of detail in individual's knowledge. On the SOLO levels from three to five, the focus is on deepening the knowledge through qualitative change where the learned detail becomes integrated into a structural pattern.

Similarly, in the knowledge management field, hierarchical levels of learning objectives are utilized to define and describe the level of individual's competence (Dalkir, 2005, p.153). Bloom's taxonomy (Bloom, 1956) of the cognitive domain is commonly used in knowledge management, and comprises six (6) levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Dalkir, 2005, p.153). Bloom's taxonomy provides a useful tool for defining what knowledge and level of performance are required from individuals. According to Dalkir (2005, p.153), Bloom's taxonomy is applicable for both assessing the technical skills and the so-called "soft skills" (marketing, communicating, etc.). Table 5. summarizes the reviewed hierarchical learning levels.

Table 5. Hierarchical learning / Levels for defining individual competence (Drejer, 2000; Biggs, 2003, p.39; Dalkir, 2005, p.153; Otala, 2008, p.124)

Drejer (2000)	Otala (2008, p.124)	The SOLO taxonomy (Biggs, 2003, p.39)	Bloom's taxonomy (Dalkir, 2005, p.153)
1 Novice	1 Novice	1 Prestructural (misses point)	1 Knowledge (remembering of previously learned material)
2 Advanced beginner	2 Advanced beginner	2 Unistructural (identify, do simple procedure)	2 Comprehension (ability to grasp the meaning of material)
3 Proficient	3 Competent / professional	3 Multistructural (enumerate, describe, list, combine, do algorithms)	3 Application (ability to use learned material in new and concrete situations by applying rules, methods, concepts, principles, laws and theories)
4 Expert	4 Experienced professional / developer	4 Relational (compare, explain causes, analyze, relate, apply)	4 Analysis (ability to break down material into its components so that organizational structure may be understood; identification of parts, relatonships between parts, recognition of organizational principles)
5 World class	5 Expert / guru	5 Extended abstract (theorize, generalize, hypothesize, reflect)	5 Synthesis (ability to put parts together to form a new whole; creative behaviors stressed in the formulation of something new)
			6 Evaluation (ability to judge the value of material based on definite criteria)

Competence increases in time through learning (knowledge acquisition) process. According to Drejer (2000), at least one full or several cycles of Kolb's experiential learning cycle (see Figure 8. in chapter 4.4.1) is required to progress to the next level of competence – each learning cycle being different from another. Moving from one level to another is hierarchical meaning that learning on higher level is dependent on learning that has taken place on lower level (Dalkir, 2005, p.153). That means that levels cannot be skipped.

For supporting the learning of individuals and internalization of knowledge, a task- and user-oriented approach is recommended (Dalkir, 2005, p.159; Otala, 2008, p.215). Separate work tasks should be identified, divided into sub-tasks with objectives, with accurate level of detail and operations - and all this should be documented. Finally, an expert should check and approve the consistency. These work tasks can be based on step-by-step process descriptions that might already exist for performing certain work tasks (e.g. maintenance service task descriptions or workbooks).

Additionally, initial competence assessment should be performed through assessment process (see chapter 4.5.1) to identify existing and latent competences. This will enable the definition of individual competences, and planning of the activation and development of the competences, as well as the suitable training methods for the competence development program.

Development of competences

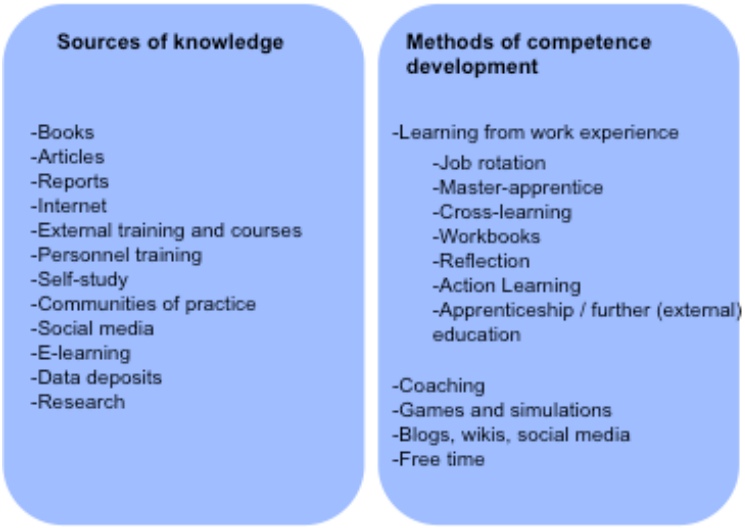
In the development of competences, various sources and methods for learning should be offered and available, as employees are individual learners (Otala, 2008, p.216), and the underlying characteristics (see chapter 4.1) of individual's competence should be considered when choosing suitable training methods (Bergenhenegouwen et al., 1997). Training, education, and information for competence development can be acquired and delivered through different sources such as external training, personnel training, and self-study e.g. e-learning, books, articles, reports, internet, communities of practice, or company wikis (Otala, 2008, p.217).

Informal practical training has received attention in companies' competence development as a method for assuring internalization of knowledge into competence (Otala, 2008, p.223; De Vos et al., 2011). Practical training, often referred to as the on-the-job training, can appear as e.g. job rotation, cross-training, apprenticeships, mentoring activities, utilization of games and simulation, or wikis (see Table 6.). In addition, free time to let the new knowledge "sink in" is often required (Otala, 2008, p.223).

Nevertheless, as it was discussed earlier (in chapter 4.3.2), individual's previous experiences on gained knowledge and skills affect how they feel about competence development. Studies have shown, that individuals with higher education or more experiences in acquiring qualifications in their career are more likely to participate in further education or training. Individuals with very little experience in education and developing their professional competence seem to be motivated only if education or

competence development is presented as part of the job requirement. (Ellström & Kock, 2008)

Table 6. List of knowledge sources and methods for competence development (based on Otala, 2008, p.216-239)



Monitoring the effects of competence development

Finally, the effects of competence development need to be measured to see how the goals for competence development were achieved and what future activities need to be considered. Ellström & Kock (2008) recommend Kirkpatrick's (1959) four evaluation levels for evaluating the effects from investments on competence development. These four levels are:

Attitudes to learning event reveal opinions on e.g. content usefulness, arrangements, and trainer/teacher (Did they like it?);

Effects on individuals reveal issues like motivation for further learning, job development opportunities, psycho-social development opportunities, cognitive effects such as increased knowledge and skills, and non-cognitive effects such as increased motivation, interest and self-confidence (Did they learn it?);

Effects on job performance reveal how "the individual becomes better at carrying out certain tasks" (Did they apply it?), and;

Effects on organization reveal changes in organizational performance such as economic, symbolic and organizational learning effects (Did the organization benefit from it?).

The difficulty in achieving positive effects increases with each level. Therefore, evaluation of the competence development effects should not be concentrated only on the first level(s), where positive results are achieved more easily. This might falsely lead to depicting positive effects for the higher levels as well. (Ellström & Kock, 2008)

In company context, the literature and studies on measuring and monitoring the competence development effects are scarce. Actual methods for evaluating and assessing competence development results are not much discussed. Scarce suggestions include collecting and measuring effects through e.g. feedback forms from learning event participants and their managers (Otala, 2008, p.254), or running performance appraisal discussions between the employee and the manager to evaluate the progress in individual's competence development among other topics of discussion (De Vos et al., 2011).

On the other hand, in the educational field, competence assessment is seen as a critical part of monitoring the effects of individual's competence development. Therefore, competence assessment is a way of bringing assurance that competence indeed has been acquired as it was planned. Competence assessment is discussed in chapter 5.1, as a method of competence assurance.

4.4.4 Competence development roles and responsibilities

In practice, the competence development activities in a company involve following stakeholders: management, human resources (HR) function, employees, line managers, and competence area responsibles (Otala, 2008, p.94). Management's task is to plan and budget competence development activities, where competence output objectives are affected by customer demands (Drejer, 2000). HR acts in a developing and maintaining role for supporting structural capital, tools and methods for competence development activities. Competence development integrates different HR practices within a company from recruitment, selection, training, career management, performance management and reward management. "Competency development can be seen as a strategic HR tool that aligns the different HR practices of an organization and brings them in line with the organization's strategy and culture while at the same time taking the broader organizational and socio-economic context into account." (De Vos et al., 2011)

However, the organizational learning perspective in companies has affected the role of HR into being more of a facilitator and consultant rather than a function providing competence development (training and other education activities). Increasingly, the

training needs are created by the managers, and the employees themselves (Athey & Orth, 1999). Hence, responsibility for the competence development has fallen into the hands of the managers. Furthermore, employees are the participants whose competences are developed and utilized.

Otala (2008, p.215) recommends that a person or a team, responsible for each competence field, should be appointed to do this work. The competence field responsible(s) can define a competence development plan, what competence and level of competence is required, and how many and who should be participating the development activities. From that information a competence development program can be created with accurate tools and methods, possible partners used, and timetable for company's competence development program. HR should define appropriate tools and methods, and support the selection of suitable ones for each case together with the competence field responsibles (Otala, 2008, s.217).

Figure 11. illustrates the relationship between the stakeholders in the development of core competences and individual competences in a company. Additionally, a performance management systems (PMS) or other system to support the managing of the content and delivery, and providing easy (online) access is recommended (Dalkir, 2005, p.158).

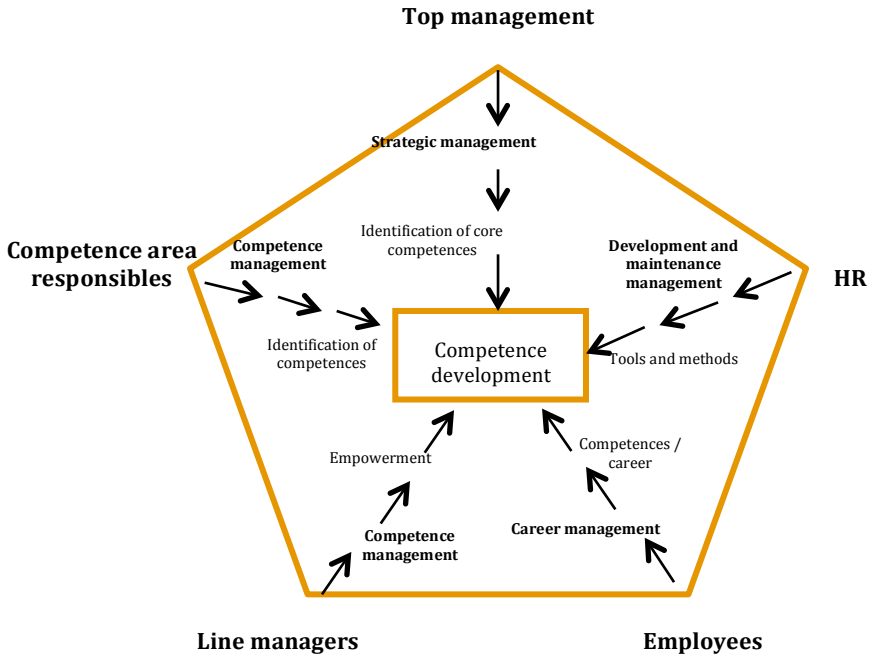


Figure 11. Competence development roles and responsibilities (based on Bergenhenegouwen et al., 1997; Athey & Orth, 1999; Otala, 2008)

To conclude this chapter on competence management practices in companies based on reviewed literature, the following remarks are made:

Intellectual capital (IC) field has brought visibility to measuring and reporting of intangible assets in a company, but provides also strategic architectures for leveraging company's intangible assets into successful performance and superior customer value. Competence development programs are one type of strategy tools, focusing on developing individuals' competences to support achieving company's strategy and goals.

A successful competence development program takes into account that the individuals must be willing and motivated to participate in developing their competences, the competence development program environment must be stimulating, and finally internal and external factors of the company context affect and must be considered. Following factors should be carefully considered when planning the program: defining competences and learning objectives, selecting methods for competence development, and monitoring the effects of competence development on individuals and organization. Additionally, the competence development practices require resources - that is the involvement of management, HR, employees, line managers, and competence area responsibles. Also preferably a management system for support should be integrated.

Based on the literature review, in companies, in individual's competence management and development practices the emphasis is largely on developing, rather than monitoring and measuring. Individual's competence is developed in various ways, but methods for monitoring and measuring the outcomes from individual's competence development are hardly discussed. Much focus is on developing competences, but not bringing assurance that competence really is achieved as an outcome.

Furthermore, the reviewed literature on experiences on competence development in companies (excluding very specific fields such as medical care) were much focused on management level e.g. project manager competence development practices in documenting experiences on methods and tools used (Suikki et al., 2006; Otala, 2008, p.317).

5. COMPETENCE ASSURANCE METHODS

Unlike in company context, the educational field research emphasizes competence assessment as a critical part of the competence development cycle (discussed in chapter 4.3.3). As the research problem concerns how to assure personnel competence, this chapter reviews some methods for bringing further assurance on personnel competence, besides the common competence development practices and monitoring the effects described in the previous chapter. Three (3) methods are discussed here as a result from research retrieval on competence assurance, competence assessment, and topics related to competence management and development. Availability of papers seemed scarce, however, it should be noted here that other methods both in literature and in practice might exist. The reviewed competence assurance methods include:

- quality competence assessment program from the educational learning context that provides an example for individual competence assurance method in the educational field. The assessment method from the educational context might serve some possibilities to be derived to some level into the company context personnel competence assurance;
- professional certifications offered by third parties for further qualification of personnel working in maintenance services especially. This assurance method based on international standards of person certification provides also knowledge on elements of the personnel certification for competence assurance;
- an in-house personnel certification program retrieved from one company context case paper describing a program where the competence development and the assessment are combined to support company's competence management. According to the paper, the in-house certification program is developed based on existing best-practice certifications.

5.1 Competence assessment adapted from educational context

Competence assessment is a fundamental and critical part of competence development cycle, in the educational field. Assurance on individual's competence and from the competence development is gained through assessment. Assessment of the learning event and outcome is done for several important reasons. These reasons include: getting feedback on how learning is proceeding (formative assessment), grading students at the

end of learning (summative assessment), and other reasons like appropriate selecting of students (candidates, participants), motivating, controlling, or satisfying public expectations according to standards or accountability (Biggs, 2003, p.141).

On the other hand, ideally the purpose of assessment is to ensure that "students learn, give them formative feedback, and motivate them" (Newstead, 2003). According to De Vos et al. (2011), in the company context, the competence assessment is a formal stage of evaluation, which is based on performance appraisal. It may lead to performance plan revision or to performance ratings.

5.1.1 Constructing assessment

Joosten-ten Brinke et al. (2007) define assessment as "all the systematic methods that can be used to gather information and evidence about student properties, based on a process, a product or the progress of a student, for the purposes of certification, placement or diagnoses in formative and summative contexts. This definition includes classical tests, examinations and questionnaires, as well as newer types of assessment, such as performance assessment, portfolio assessment and peer assessment."

Table 7. Assessment methods and types of learning being assessed (adapted from Biggs, 2003, p.210 Table 9.2)

Assessment method	Type of learning being assessed
Extended prose, essay type	
essay exam	rote, question-spotting, speed structuring
open-book	as for exam but less memory, coverage
assignment, take-home	read widely, interrelate, organize, apply, copy
Objective test	
multiple choice	recognition, strategy, comprehension, coverage
ordered outcome	hierarchies of understanding
Performance assessment	
practicum	skills needed in real life
seminar, presentation	communicating skills
posters	concentrating on relevance, application
interviewing	responding interactively
critical incidents	reflection, application, sense of relevance
project	application, research skills
reflective journal	reflection, application, sense of relevance
case study, problems	application, professional skills
portfolio	reflection, creativity, unintended outcomes
Rapid assessments (large class)	
concept maps	coverage, relationships
Venn diagrams	relationships
three minute essay	level of understanding, sense of relevance
gobbets	realizing the importance of significant detail
short-answer	recall units of information, coverage
letter to a friend	holistic understanding, application, reflection
cloze	comprehension of main ideas

Varying practical methods for assessment exist and some are listed by Biggs (2003, p.210) in Table 7. It is important to choose a suitable format for assessment (Biggs, 2003, p.210). Different and multiple assessment methods, both new and classical assessment types, should be combined in a competence assessment program (Baartman et al., 2006).

All competence assessment programs need to be aligned with the targets of the learning process i.e. the acquisition of competence (Baartman et al., 2006). In the assessment stages (Biggs, 2003, p.161, see Figure 12.), first, the criteria for assessing the individual's competence should be set, and linked to the competence criteria (see chapter 4.4.3). Second, the assessment methods should be chosen based on the set assessment criteria, evaluating which evidence provides the relevant proof for evaluating the competence. And third, the assessment is made based on judging how the evidence meets the set assessment criteria.

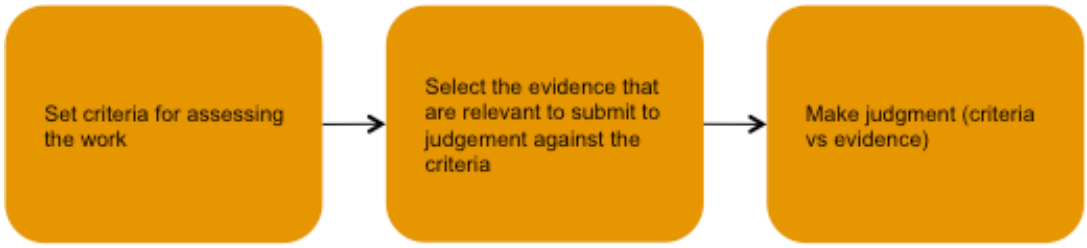


Figure 12. The stages of competence assessment (based on Biggs, 2003, p.161)

Following the same basic stages, Joosten-ten Brinke et al. (2007) present more detailed steps for the assessment process. These steps include:

Assessment plan is designed based on assessment policy. Design includes defining and determining assessment purpose, rules, candidates and traits to be assessed (elementary or complex), assessors, assessment types, scenarios for mandatory and optional units of assessment;

Item construction is indicated by assessment plan and candidate's traits. Item construction comprises e.g. essay, multiple-choice question, single case problem, or other;

Assessment construction combines items into units of assessment. Unit of assessment will be presented to candidate and it comprises one or several items;

During assessment session, one or more units of assessment are presented to the candidate. Candidate has an assessment take that generates item responses (e.g. answer, report, performance);

Assessor (e.g. person, computer, peer candidate, candidate themselves) assesses item responses. Transformation rules are used to response (value) into a score (an assessment indicator score and a trait score);

Decision is based on the score of the candidate on a certain assessment take, according to assessment plan and decision rules.

5.1.2 Assessment quality

Baartman et al. (2006) developed a new framework of quality criteria for competence assessment programs specifically. These twelve (12) quality criteria and their descriptions are:

Authenticity. Competence assessment program resemblance to the future professional life;

Cognitive complexity. Assessment task should reflect the presence of cognitive skills;

Meaningfulness. Value for teacher and student (assessment linked to personal interest, students involved in planning and defining themselves when ready for assessment);

Fitness for purpose. In relation to the competence development and curriculum;

Acceptability. By those in the profession;

Fitness for self-assessment. Comprehension of how one manages particular task in relation to explicit criteria;

Fairness. Bias to be avoided;

Transparency. Clear and understandable to all participants;

Educational consequences. Evidence from intended/unintended, positive/negative effects from assessment is to be collected;

Reproducibility of decisions. Assessment decisions independent of time and assessor;

Comparability. Consistent and responsible competence assessment program and assessment conditions;

Cost and efficiency. Important as competence assessment program is more complex and difficult to carry out than classical tests. Relates to time and resources needed to develop and carry out competence assessment program, therefore evidence is to be collected to argue for investment.

The new types of assessment, such as performance assessment, create challenges especially in defining the quality criteria of assessment, and finding time and resources for the development of reliable and valid assessments (Joosten-ten Brinke et al., 2007). Competence assessment program implementation success is critically related to the cost and efficiency factor, that is the time and resources required (Baartman et al., 2006). Technology can provide help in assessment for some part.

5.2 Professional certification

Since the late 1960's the amount of certification programs has been rapidly increasing, and there are now certification programs covering nearly all professional and technical fields (Wiley, 1995). In addition, there are often many certifications available for a professional of a certain field for opportunities of specialization (Lysaght & Altschuld, 2000). According to the standard for person certification "the overall purpose of certification of persons is to recognize an individual's competence to perform a task or job" (EN ISO/IEC 17024:2012). Thus, professional certification provides "proof that the holder is qualified to perform successfully in a designated occupation or job function" (Wiley, 1995). Certification serves mainly at the individual and occupational levels.

"All certification systems share similar principles and techniques to reach their goals" (Robertson, 1999). Furthermore, professional certification aims at measuring individual's competence, and enhancing of the profession and credibility of the qualifying professional (Wiley, 1995; Lysaght & Altschuld, 2000). These goals of professional certification are "fulfilled by adhering to prescribed standards", and professional associations regulate and administer certification (Wiley, 1995). The purpose is to provide assurance to the customer that an individual professional is approved by a reliable authority (Lysaght & Altschuld, 2000). According to Robertson (1999) "certified personnel is evidence that organization generates products or services superior of quality and value". Table 8. lists different assessment methods used by various constituencies (Lysaght & Altschuld, 2000).

Table 8. Professional competence assessment methods in use by various constituencies (adapted from Lysaght & Altschuld, 2000)

Level of assessment / evaluation	Competence assessment method
Employee	Peer comparisons Portfolios / checklists Feedback from mentor, supervisor Self assessment / intuition
Customer	Personal sources / informants Media Subjective impressions
Employer	Written testing Observation Supervisor ratings Peer review Client satisfaction surveys Chart / report audit Quality assessment programs
Regulatory agencies	Certification examinations Complaints boards Continuing education units Portfolios

5.2.1 International standard for all certification of persons

EN ISO/IEC 17024 is an European standard for all certification of persons. This standard provides principles and requirements for a body or organization conducting certification of persons. The use of standard enhances consistency, comparability and reliability between all individual certification. EN ISO/IEC 17024 states that each certification scheme for persons should be designed to be based on this standard, and the requirements of market needs or government requirements. (EN ISO/IEC 17024:2012)

The standard emphasizes the impartiality of certification "basing on objective evidence through a fair, valid and reliable assessment", the impartiality of the personnel providing certification, and creating an environment of confidence, trust, responsiveness, and responsibility. To meet these requirements of impartiality, a certifying organization or body must be structured and managed according to the standard requirements. Also, a certification scheme for persons must be created, that comprises the competence requirements for persons. Certification scheme also needs to be continuously reviewed and validated. Certain requirements for management system are included as well. Finally, the person certification process must be structured according to standard. (See Figure 13.)

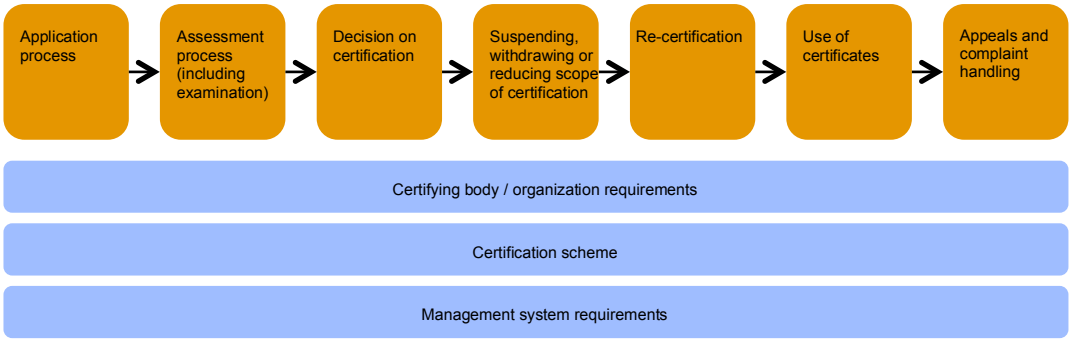


Figure 13, Person certification process and management requirements (based on EN ISO/IEC 17024:2012)

Certification process comprises eight steps according to the standard. However, in Figure 13. the two final process steps are combined. Here are short descriptions of the certification process steps (EN ISO/IEC 17024:2012):

Application process. Applicant submits signed application, and receives confirmation of compliance from certifying body;

Assessment process. Assessment methods and mechanisms defined in the certification scheme are applied. These can be by written, oral, practical, observational or other reliable or objective means. A competent examiner provides professional judgment;

Decision on certification. According to certification scheme, sufficient information for decision making must be collected, all certification requirements must be fulfilled, and finally, the certificate is provided to the certified person;

Policy and procedure for *suspending, withdrawing or reducing the scope of certification* must be created;

Re-certification process. According to certification scheme, procedures for confirming continued competence of the certified person must exist. Assessment for re-certification should include: on-site assessment, professional development, structured interviews, confirmation of continuing satisfactory work and work experience records, examination, checks on physical capability in relation to the competence concerned;

Use of certificates. Certifying body must have certified person to sign agreement to avoid misuse of certificates, logos and marks;

Appeals against decisions on certification. A documented process must be in place to include processes for receiving, validating, investigating, tracking, recording, processing, and correcting appeals;

Complaints. A documented process must be in place for receiving, evaluating and making decisions on complaints.

5.2.2 Certificates for maintenance personnel

Certification for maintenance personnel, from maintenance technicians to maintenance managers, is offered at least in Europe (EFNMS-a; EFNMS-b), and in the U.S. (SMRP-a; SMRP-b). In Canada, there is also a certification program for maintenance management professionals on manager level, that offers both training and certification (PEMAC). Also, for example, a certificate for condition monitoring and diagnostics of machines exists, which is based on an international standard ISO 18436 (Inspecta). Literature on experiences from the benefits or limitations related to these particular professional certifications was not found. Table 9. lists the knowledge and skills requirements of these certificates.

Competence requirements for maintenance personnel according to the European qualification based on the CEN/TR 15628 standard include both general competences and responsibilities e.g. communication, work processes and tools, and context related competence; and task related competences and responsibilities focusing on competences specifically required in maintenance services (CEN/TR 15628). The American certification SMRP, on the other hand, requires for the technician level to assure only the maintenance work specific competence, and any soft (or relational) skills or other skills are included (SMRP-a).

The assessment methods used for these certificates seem to focus mainly on time-limited exams. Both SMRP and PEMAC assess candidates via exams, and SMRP further specifies that multiple choice questions are utilized in the assessment. In addition, PEMAC requirements include a 30 hours project work for the final knowledge module. The assessment details and methods used by EFNMS and Inspecta were not available. (SMRP-a; SMRP-b; PEMAC)

Table 9. Some professional certificates offered for maintenance personnel (CEN/TR 15628 standard; EFNMS-a; EFNMS-b; SMRP-a; SMRP-b; PEMAC; Inspecta)

CERTIFYING BODY (STANDARD)	CERTIFICATION LEVEL Technician	Supervisor / Engineer	Manager
EFNMS in Europe (CEN/TR 15628)	"A craft person with at least two years of practical experience in maintenance and sufficient theoretical knowledge to independently perform and coordinate maintenance activities (responsible for short term decisions and communication)." **General competences and responsibilities** Corporate/company environment, Work planning, Team work and communication, English language, Information technology, Training and instructions, Quality assurance, Environment, Automation **Task related responsibilities and competences** Maintenance objectives, Maintenance concepts, Restoration techniques, Maintenance terminology, Contracting, Laws and regulations, Condition based maintenance (CBM) / condition monitoring, Fault finding techniques, Improvement techniques, Documentation, Spare parts management, Materials technology	"A person with at least two years of practical experience in maintenance and sufficient theoretical knowledge to independently perform and coordinate maintenance projects (responsible for medium term decisions)." **General competences and responsibilities** Corporate/company environment, Work planning, Team work and communication, English language, Information technology, Training and instructions, Quality assurance systems, Environment, Automation, Occupational health and safety **Task related responsibilities and competences** Maintenance objectives, policies and strategies, Maintenance concepts and methodologies, Restoration techniques, Maintenance terminology, Partnering and contracting, Laws and regulations, Condition based maintenance (CBM) / condition monitoring, Fault finding techniques, Improvement concepts and techniques, Documentation management, Spare parts management, Materials technology	"A person with approved engineering background and sufficient theoretical knowledge to perform and co-ordinate maintenance." **General competences and responsibilities** Corporate/company environment, Work planning, Team work and communication, English language, Information technology, Training and instructions, Quality assurance systems, Environment, Automation, Occupational health and safety **Task related responsibilities and competences** Maintenance objectives, policies and strategies, Maintenance concepts and methodologies, Restoration techniques, Maintenance terminology, Partnering and contracting, Laws and regulations, Condition based maintenance (CBM) / condition monitoring, Fault finding techniques, Improvement concepts and techniques, Documentation management, Spare parts management, Materials technology
SMRP in the U.S.	A) maintenance practices B) preventive and predictive maintenance C) troubleshooting and analysis D)corrective maintenance		A)Business and Management B)Manufacturing Process Reliability C)Equipment Reliability D)Organization and Leadership E)Work Management
PEMAC in Canada			Module 1 - An Integrated Strategy for Maintenance Management Module 2 - Production and Operations Management for the Maintenance Manager Module 3 - Human Resources Management for the Maintenance Manager Module 4 - Financial Management for the Maintenance Manager Module 5 - Developing and Implementing Maintenance Tactics Module 6 - Maintenance Work Management Module 7 - Computerized Maintenance Management Systems Module 8 - Capstone Project
INSPECTA in Finland (ISO 18436)	International standard ISO 18436 for condition monitoring and diagnostics of machines provides requirements for both training and certification of personnel. Qualifications cover certifications for vibration analysis, infrared thermography, and lubricant analysis diagnostics		

5.3 In-house certification of company personnel

The in-house certification strategy presented here combines both competence development (training for certification) and competence assessment practices (testing) – integrated into one framework in a company context. Robertson (1999) provides a framework for in-house certification of company employees basing on combination from best-practice certifications (see Figure 14.), and to support companies in further analyzing the benefits and tradeoffs related to in-house certification.

Robertson (1999) criticizes external professional certification programs (such as professional certification discussed in chapter 5.2) for focusing on knowledge testing only, and neglecting the direct measurement of "hands-on expertize". In addition, "[external]

certifications do not indicate mastery of the specific competencies required by real-world jobs inside particular company". Hence, Robertson (1999) presents an in-house certification program that is based on company's internal standards for knowledge, skills and competences, and which focuses on independently educating, motivating and certifying company's own employees. According to Robertson's (1999) experiences, in-house certification benefits in achieving company goals and "boosting" employees' careers. However, certification for wrong individual or organizational reasons is to be avoided.

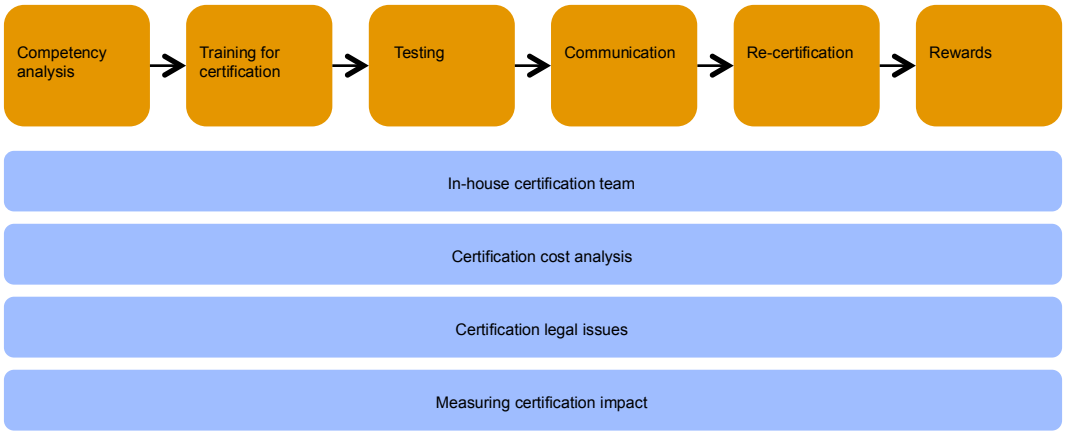


Figure 14. A framework of In-house certification of company personnel (adapted from Robertson, 1999)

According to Robertson (1999), an in-house certification framework should be seen as a performance management tool. This framework includes six (6) process steps, and certain support structures that are required for successful program management. These elements are reviewed in the following sub-chapters.

5.3.1 Process steps for in-house certification program

Competence analysis is a systematic process for observation and identification of "job behaviors that constitute effective performance". This process should comprise four tasks: valued accomplishments related to a job should be identified, necessary competences for reaching the accomplishments should be decided on, competences on individual and team levels should be identified, grouped, and visualized emphasizing effective job performance and engaging people to use the materials, and finally, the competences and related key performance requirements should be validated with competent performers, subject matter experts, and line managers. (Robertson, 1999)

Training for certification is described as an essential part of certification. Training should be based on the identified competences from the analysis, providing clear scope for certification and what employees need for succeeding in testing. Nevertheless, training is affected by environmental opportunities and constrains such as time, resources, budget, trade union agreements, etc. (Robertson, 1999)

Testing should be formal work-related testing, and focus on assuring job-related knowledge and skills, as well as competence for high-fidelity certification resulting from substantial training and hands-on job experience. Robertson (1999) utilizes three competence levels in testing – namely entry level, expert level, and master level – where the testing methods used vary for each level (see Table 10.). Additionally, testing should include one-to-one dialogs with employees. Testing, however, involves costs and efforts, and expenses increase with each testing level. Nevertheless, ”a valid, reliable testing is unarguably the critical requirement of every certification, the use of professional test consultants in a first-time certification may be worthwhile investment”. Other limitations related to testing and evaluation according to Robertson (1999) is the current elementary state of the field, as well as the evaluators affecting the quality of certification program in competence testing.

Communication should focus on promoting certification benefits for both individuals and organization. Individuals can be motivated by communicating ”self-actualizing” values listed in Table 10. According to Robertson (1999), motivating employees will further benefit in creating employee engagement and increasing commitment. Communication channels can include senior management briefings to employees; newsletters, flyers, or posters; induction ceremonies; achievement awards for certified employees or teams; bonus, incentive, or pay schemes tied to certification; and certification included in internal job vacancy announcements. (Robertson, 1999)

Table 10. Competence levels for testing (based on Robertson, 1999)

Competence levels for testing

LEVEL	FOCUS OF TESTING	TEST
1 Entry level	Knowledge	Tests recall of facts and information and procedures and may test some analysis or application
2 Expert level	Knowledge Skills	*Tests retention and analysis of information and tests individual mental or physical skills and may combine written or in situ testing*
3 Master level	Knowledge Skills Competence	Tests matches work processes and conditions and demands and test scenario is job environment or very close approximation

Re-certification purpose is to make sure individuals comply with competence requirements as the requirements (and work tools and techniques) change or are updated. Another purpose is to promote and track professional growth and commitment over time. (Robertson, 1999)

Rewarding should be considered with certification program, and meaningful and cost-effective reward system should be integrated (see Table 11.). However, according to Robertson (1999) "experiences show that correlation between the monetary value of rewards and motivation is not significant. Conversely, employees see recognition as a key element in motivation."

Table 11. Methods for motivating employees for certification (based on Robertson, 1999)

Methods for motivating employees for certification

-Increased confidence and self-respect
-A desire for personal change,
-Higher salary,
-Bonus and incentives,
-A needed credential,
-Better or more meaningful work,
-A piece of one's professional qualifications,
-Link to new specialization

5.3.2 Support structures for managing in-house certification

For successful running of an in-house certification program certain structures and procedures, in addition to the process steps reviewed above, need to be in place (Robertson, 1999):

An *in-house certification team* needs to be in place comprising roles such as certification manager, off-site administrator, on-site coordinator, and evaluators. Especially, the role of evaluators is critical, and evaluators should have competence in the subject matter, in conducting testing, possess communication skills, and knowledge in certification principles. According to Robertson (1999), evaluators ”are often certified in advance by an external authority to lend credence or prestige to the program.” (Robertson, 1999)

Certification cost analysis takes into account the expenses related to personnel resources, hardware, materials, and facilities, as well as the development, production, and delivery phases. Time as a hidden cost should be factored in for the analysis. (Robertson, 1999)

As a great benefit, an in-house certification program creates objective, systematic and structured certification, as well as documented certification data, which provide ”an *intrinsic defense against legal liabilities*” for the company from both developing employee competence and testing competence. (Robertson, 1999)

Measuring certification impact and benefits is difficult, but highly important and necessary for continuous improvement of practices. Robertson (1999) recommends that measuring should be conducted by utilizing Kirkpatrick’s (1959) four levels of evaluating the effects on individuals, their competences, on job performance, and on business results (see also chapter 4.4.3). Data for evaluating can be retrieved e.g. from testing. (Robertson, 1999)

6. FRAMEWORK OF FSE COMPETENCE ASSURANCE

Based on the literature reviewed in the previous chapters, it becomes obvious that the FSE and their competence are critical in creating service quality and competitive advantage in industrial maintenance services (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Mathieu, 2001). Challenges related to managing maintenance services and the FSE competence stem from the challenges related to the manufacturing shift from products to services, as well as to the new focus in the industry emphasizing the management of intangible assets (Matthyssens & Vandenbempt, 1998; Oliva & Kallenberg, 2003; Brax, 2005; Baines et al., 2008).

Although the IC management field provides models for support, the actual experiences from company practices seem to be scarce in literature. Regarding competence assurance, as being the main interest in this research, the methods had to be derived mainly from the educational field context (Biggs, 2003; Newstead, 2003; Baartman et al., 2006; Joosten-ten Brinke et al., 2007), and the professional certification of maintenance personnel (Wiley, 1995; Lysaght & Altschuld, 2000; EN ISO/IEC 17024:2012) external to companies' internal competence management practices.

Nevertheless, even with the methods reviewed, the actual experiences and evidence on practices, and the benefits and tradeoffs were not found. For this research, the findings from the literature indicate that in general, competence assurance in the company context competence management practices hardly exists. On the other hand, it was criticized in the reviewed literature that research has not been able to follow competence related practices taking place in companies (De Vos et al., 2011). Nevertheless, competence assurance and personnel certification are supposed to be based on similar principles regardless of the context (Robertson, 1999). However, the actual methods used for conducting the assessment or testing of individual's competence should vary according to the competence at hand (Biggs, 2003). Additionally, integrating competence assessment practices into a competence program comes with the significant time and resource tradeoffs (Baartman et al., 2006; Joosten-ten Brinke et al., 2007). Other challenges relate to meeting the assessment quality requirements (Baartman et al., 2006, see chapter 5.1.2).

Regarding the reviewed competence assurance methods, the benefits from integrating an assurance method (in chapter 5) include: gaining proof of individual's competence and

assurance that individual is qualified for their job; motivation and boosting for employee's career; and increased credibility and trust in the eyes of customer (Wiley, 1995; Lysaght & Altschuld, 2000; Biggs, 2003, p.141; Newstead, 2003). The professional certifications especially were said to provide credibility and trust as individual is approved by a reliable and impartial authority (Wiley, 1995; Lysaght & Altschuld, 2000). However, an in-house approach to certification was also claimed to provide this evidence for customers, as legally valued data from both developing employee competence and testing competence would be available (Robertson, 1999). In addition, the benefits from an in-house certification over an externally provided professional certification was that competence development and testing would be based on company's internal standards and critical focus on testing hands-on expertize could be included unlike in a professional certification (Robertson, 1999). However, with both the professional and the in-house certification it remains unclear whether the customer sees any extra value in a certified employee of the service providing company.

Regarding the FSE competence requirements, the professional certification offered by EFNMS in-line with the CEN/TR 15628 standard provided the most detailed listing (see chapter 5.2.2, Table 9.). Competence categories for service technicians and engineers comprised: a) task related competences to perform technical maintenance service and maintenance tasks for products and plants including also requirements e.g. for law and regulation and documentation; b) general competences entailing company environment, work planning, team work and communication, English language, information technology, training and instructions, quality assurance, environment, and automation. Furthermore, examination and utilizing multiple-choice questions seems to be a common method for assessment for professional certifications. (CEN/TR 15628:2007:E; SMRP-a; SMRP-b; PEMAC)

The findings from the reviewed literature (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Nguyen, 1998; Tsang, 2002; Peterson et al., 2004; Kutvonen, 2012) were aligned with the CEN/TR 15628 standard regarding that both technical and other competence (e.g. environmental constrains, quality control, health and safety, problem-solving, team dynamics) were emphasized. Furthermore, in the literature, the soft (or relational) FSE competences (reliability, responsiveness, empathy, clear communication, credibility) were recognized having strong impact on customer perceived service quality, and therefore critical requirements for FSE competence (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Nguyen, 1998; Peterson et al., 2004; Kutvonen, 2012).

Figure 15. summarizes the literature review conducted in the previous chapters into a framework of competence assurance, with the research problem focus on the FSE competence required in industrial maintenance services especially.

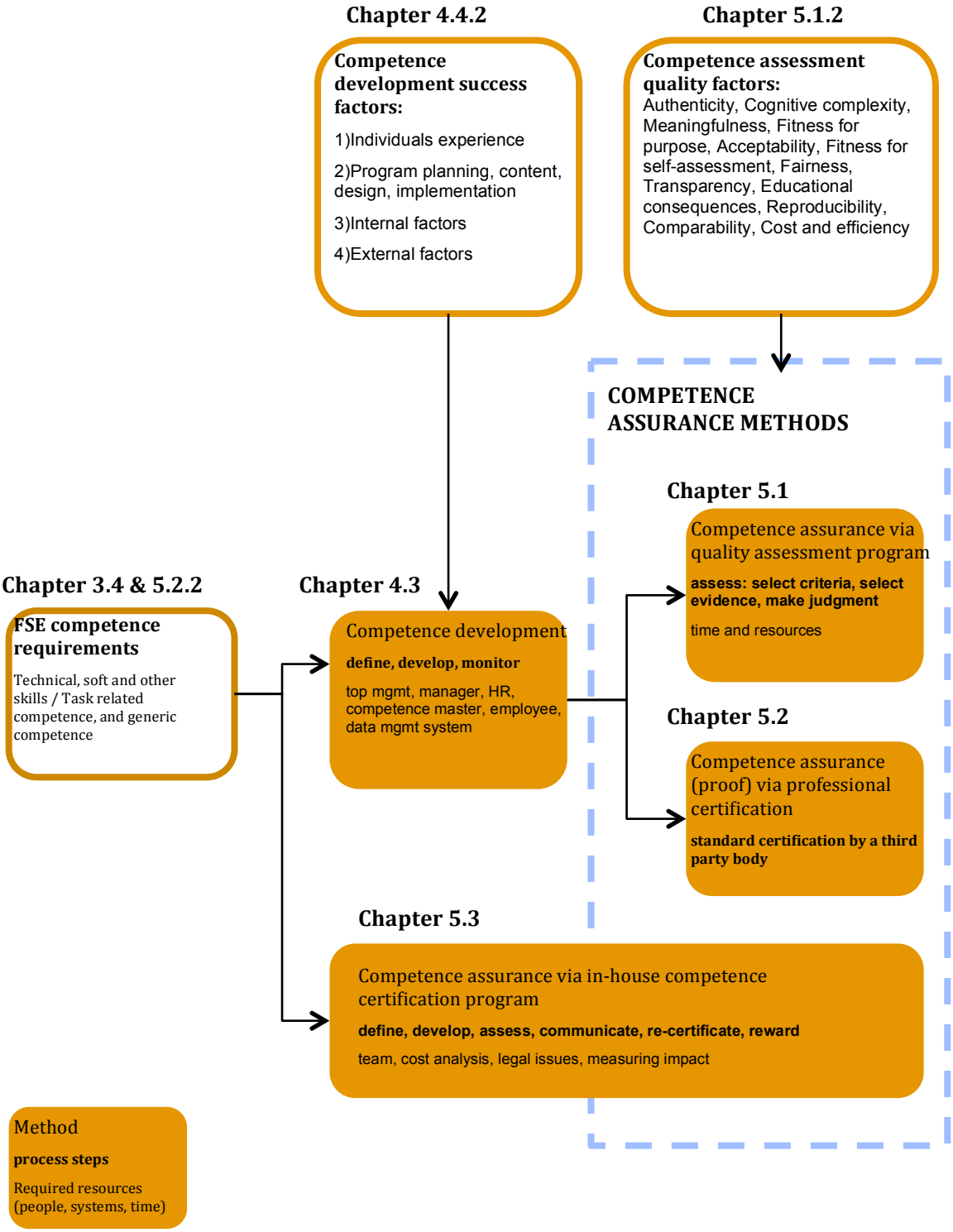


Figure 15. Framework of FSE competence assurance

7. RESEARCH METHODOLOGY

This thesis research was commissioned by the company A. The company A is a global, Finland based industrial technologies and services provider that has extensively expanded its service business over the past five years. The company A has grown both organically and through acquisitions to acquire more expertize and resources to complement its technology and service offering. Company's service offering comprises also different maintenance services e.g. maintenance inspections, preventive maintenance, corrective maintenance, and emergency service. Furthermore, support in the maintenance service development and developing competence management practices is needed.

For this study, the company A's interest and challenges related to a problem of how to solve the need to assure the competence of their field service engineers (FSE) delivering maintenance services, and who are dispersed globally. Some form of personnel certification was seen as an attractive option. Furthermore, in the company A, field service engineer (FSE) certification was hypothesized to bridge the ongoing FSE competence mapping and the technical training structure into a more comprehensive and structured practice of competence management.

The lack of existing research and practices for competence assurance and personnel certification in the context of industrial maintenance services was anticipated and recognized by the company A. Therefore, it was clear for the company A that empirical research in the form of benchmarking practices of other companies in industrial services would be preferred. The perceptions on the shortage of literature and recorded experiences regarding the research topic were further reinforced during the literature review conducted in the previous chapters.

This study was conducted as a qualitative multiple case study comprising the defining and designing phase, the collecting and analyzing phase, and finally, the organizing and reporting phase (Eisenhardt, 1989; Yin, 2003; Barratt et al., 2010; see Figure 16.). The following sub-chapters review and clarify the phases in more detail.

7.1 Multiple case study design

This study was conducted as a qualitative multiple case study. A qualitative case study research is an empirical research for covering a topic or phenomenon in its real world

contextual conditions aiming to reveal intrinsic issues related to the topic of study (Yin, 2003, p.13; Barratt et al., 2010). In this research the goal was to search for a method for FSE competence assurance through benchmarking existing practices. Furthermore, considering multiple cases, instead of only a single case, increases the probability of replication in research results leading to a stronger study design (Yin, 2003, p.19, 32).

The following research questions were formulated: what kinds of methods exist for personnel competence assurance in companies (both in general and in industrial maintenance services companies), and what are the method key elements; is personnel competence assurance perceived beneficial for companies, employees, and customer in industrial maintenance services; how do we evaluate what field service engineer (FSE) competence is critical and how it should be assured. Hence, for conducting the multiple case study, the unit of analysis was defined as *'in-house competence assurance and/or personnel certification activity for maintenance service technicians/engineers run by an organization in industrial services'*. This definition for the unit of analysis further functioned as the case selection criteria (Yin, 2003, p. 21). The case selection criteria was formulated as follows:

- case organization is running fully or partly, or has developed, an internal personnel certification activity, and;
- personnel certification activity is targeted to technical services personnel in equipment or plant maintenance services.

Suitable cases were identified and selected from company A, company B, and company C. Within one case company, namely in the company A, several organizations were performing personnel certification independently from others. Therefore, these three cases within the company A were justifiable recognized sufficiently independent from each other, and hence, recognized as separate cases.

Altogether five cases were examined for this thesis: A1, A2, A3, B1, and C1. The case organizations were located in South Africa (A1), Australia (A2, A3), and Finland (B1, C1). In three cases the personnel certification activity was run by the organization itself, but was accredited (and controlled) by an external authority (A1, A2, C1). For the other two cases the personnel certification activity was solely internal activity within the organization, and based on internally standardized practice (A3, B1).

7.2 Collection of data

Designing of the data collection was based on tentative literature review, on discussions on topic with different parties in the company A, and on reflections on readings and discussions. The five case studies were mainly conducted as open-ended interviews (Yin, 2003, p.90) that were semi-structured according to themes. Open-ended interviews are common method for collecting evidence for case studies, and target to ask informants (interviewees) about "the facts of a matter as well as their opinions about events" (Yin, 2003, p.90). Furthermore, interview as the source of evidence is both targeted as it focuses on case study topic directly, and insightful as it provides perceived causal inferences (Yin, 2003, p.86).

For this multiple case study the open-ended interview themes included: purpose for certification, used criteria for assessment and certification, role of assessor, assessment practices, certification practices, reviewing of certification (monitoring activity), employees' motivation, and final questions (gained benefits, experiences, lessons learned). Furthermore, the interview questions in each theme were adjusted to each interview according to the case at hand. Also during the interviews some topics were discussed already within another theme, and in those situations the particular question was not presented again later even if it belonged to the current theme questions. (See Appendix 1. for case interview themes and questions.)

The case interviews were conducted face-to-face in Finland (A1, B1, C1) and via collaboration tool calls (A2, A3) during April-July 2013. One (1) individual per case was interviewed. Therefore, altogether 5 interviews were conducted for this multiple case study. Duration for each interview was approximately 2-3 hours. The interviewed informants were selected to be either the matter experts or the responsible managers for the personnel certification activity in the case organizations. The interviewed informants were responsible either for the certification activity, or for the development and implementation of the activity in the organization:

- Manager of safety, health and environment in the case organization, and previously head of training in the organization. Informant has experience in managing and administrating organization's personnel certification activity and meeting external authority requirements since 5 years. Informant is also an accredited trainer in South Africa (A1);
- Manager of site environment and safety, and head of personnel certification activity in the case organization since 2 years. Informant is responsible for managing and

assuring compliance of personnel certification activity according to external authority requirements. Informant has also previous experience on administrating similar personnel certification (A2);

- Training manager responsible for the case organization's personnel competence development and training. Informant developed the personnel certification program in the case organization. Informant has many years of experience in developing, administrating and training competences in different industries (A3);
- Project manager in the development and implementation project of the personnel certification program since two years. Project team involves also the company's technology portfolio experts and the training organization personnel (B1);
- Head of compliance control function in the case organization, and responsible for the personnel certification activity compliance according to the external regulations (C1).

Case interviews for two cases (A2, A3) were recorded, transcribed, and the individual case reports were written. Later on obscurities in these cases were clarified via email from the informants. For two other cases (B1, C1) the individual case reports were written based on the interview notes, and reviewed and approved by the informants approximately one month after the case interview to confirm the collected data. For the remaining case (A1) the individual case report was written based on the interview notes, and some clarifying questions were sent later via email to the informant to confirm obscurities and gaps in the interview notes. (See Appendix 2. for data collection details.)

Additionally, during all the interviews each informant recommended or provided other sources of evidence that were related to the case personnel certification activity (Yin, 2003, p.90). These other sources of evidence included: recommendation to contact the personnel certification training manager (administrator and accredited trainer) via email for further details (A2), personnel certification communication materials (A1, A2, A3, C1), forms of certification activity documentation (A1, A2, A3, C1), training plans (A3, B1), assessment forms (A1, A2, C1), review on utilized management system and tools in personnel certification (A2, B1), and requirements from external authority (e.g. authority internet sites) (A1, A2, C1). Information retrieved from these other sources of evidence was included in each of the individual case reports.

7.3 Analysis of data

The qualitative data analysis was performed for the collected data that was documented in the individual case reports (Yin, 2003, p.109). The analysis of data started by conducting within-case analysis that was performed in order to become more familiar with each case

as a stand-alone entity, and to create more insight (Eisenhardt, 1989; Miles & Huberman, 1994, p.173; Barratt et al., 2010). This was followed by cross-case analysis in focus for deepening the understanding and explanation by looking for similar patterns and differences between the cases (Yin, 2003, p.116, 133; Miles & Huberman, 1994, p.173; Barratt et al., 2010). The conducted qualitative data analysis (within-case and cross-case) comprised concurrent activities of data reduction, data display, and conclusions drawing (Miles & Huberman, 1994, p.10).

In the within-case analysis, each individual case report was revised and the data was transferred to a display document consisting of extended text, matrices, figures and process illustrations (Miles & Huberman, 1994, p.11). This was done to create a new differently categorized display for further analysis with more focus on the study's research questions: methods for personnel competence assurance and key elements; perceived benefits for companies, employees, and customer; and assured field service engineer (FSE) competence. The display document categorized and sub-categorized interview themed data from individual case reports into 6 main categories, and simultaneously some data that was evaluated redundant, was neglected (Miles & Huberman, 1994, p.10). The new (main) categories comprised: case certification activity context and purpose; how case certification (process) is run; what resources are needed for case certification activity (material, people, data management and administration, costs); what benefits certification activity generates; and what challenges certification activity has created and revealed.

In the cross-case analysis, two sets of cross-case displays were made in steps, and cases were examined based on the main categories developed earlier in the within-case analysis, and by pairing cases for further analysis (Eisenhardt, 1989). These displays comprised extended text, matrices, figures and process illustrations (Miles & Huberman, 1994, p.11). Furthermore, in the cross-case analysis, the individual cases were kept and handled as entities, and only the individual case displays from the within-case analysis were used at this point (original individual case reports were excluded) to avoid misuse of data (Miles & Huberman, 1994). Finally, the conclusions drawing based on the within-case and the cross-case analysis was performed.

7.4 Validity and reliability

Attention to the research design was given to promote the validity and reliability of this study, regarding for both the collecting and analyzing the data, and the conclusions drawing for the study.

For one, considering multiple cases promotes external validity, and provides stronger research compared to a single case study (Yin, 2003, p.19). Furthermore, in the data collection phase, to increase the construct validity and reliability of the study following factors were included: considering multiple sources of evidence (interviews and other sources of evidence), recording interviews (when possible), and having the informant review and confirm the individual case report (Yin, 2003, p.35; Barratt et al, 2010). Additionally, through the inclusive data analysis (both within-case and cross-case) and utilizing the multiple displays the internal validity of the study was enhanced (Yin, 2003, p.36). The research methodology described above is illustrated in Figure 16.

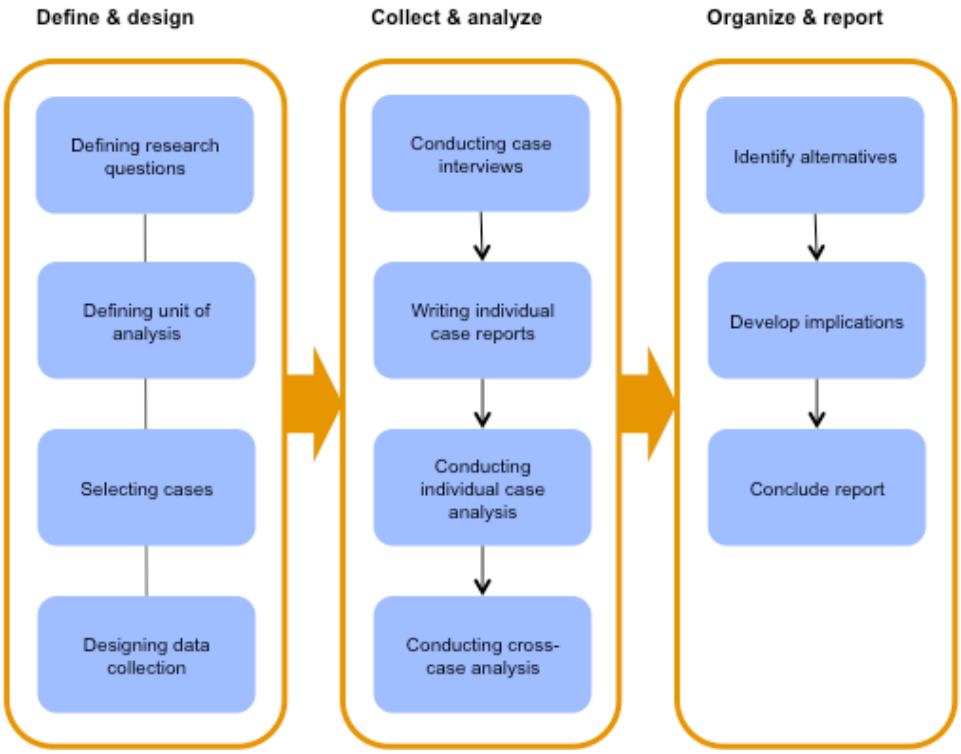


Figure 16. Research methodology

8. RESEARCH FINDINGS

Five (5) case studies were conducted for this thesis. The multiple case study findings are reviewed in this chapter. The general case descriptions are presented first to give an overview on each case and its prevailing personnel certification context and activity. This is followed by the findings from the cross-case analysis: the basis for competence assurance and personnel certification practices; methods and its key elements for running a competence assurance and personnel certification program; and personnel certification experiences from industrial maintenance services field. Finally, the alternatives to personnel certification of field service engineers (FSE) in industrial maintenance services are discussed based on the findings.

8.1 Case descriptions

8.1.1 Case A1 – National requirements for employee competence development, as well as the local mining industry and customers create pressure for having national qualifications

Case A1 concerned a service organization in the mining and metals industry services, located in South Africa. This is an organization within the company A. The personnel certification activity in the organization is based on meeting both external and internal needs and requirements for personnel competence assurance and qualification. As external factors, there are national requirements for employee competence development, as well as the local mining industry and customers that create pressure for having national qualifications. This pressure is largely resulting from the Black Economic Empowerment (BEE) policy in South Africa, which is set by law to improve and ensure equality in the employment and opportunities regardless of individual's background. Hence, employers in South Africa follow the national qualification framework and standards for all employee competence development and qualification.

For this case, the personnel of focus works in customer service, and in operation and maintenance on customer sites. This workforce group comprises both permanent employees and sub-contractors working as service technicians, engineers, and operators. The organization is providing these employees with product and technology specific training, and issuing them with qualifications. According to the manager of safety, health

and environment (also head of the personnel certification activity), approximately 5-10 employees are being qualified yearly.

The organization is qualifying employees as an accredited training organization by the national sector authority, that is the Mining Qualification Authority (MQA) in South Africa. Hence, the organization is obligated to follow the requirements of MQA. MQA maintains the quality for all sector related training and education, assessment services, and issuing qualifications. Customers are also related to the sector authority, and this makes the authority even more significant actor in the qualification field in South Africa.

In addition, internally the organization targets to develop their service workforce competence and have assurance on safety on the work performed on customer site. For this purpose especially, the manager of safety, health and environment has implemented an additional practical assessment, called the *Plant Task Observation* (PTO). The PTO assessment provides evidence on practical competence of the employee. This assessment is not included in the requirements of the national qualification framework.

8.1.2 Case A2 – Being a registered training organization provides flexibility to issue national qualifications for (short term) employees to meet customer requirements

Case A2 examines an Australian company (an organization recently acquired by the company A) providing grinding mill relining services and mine services – the latter comprising maintenance shutdowns, construction work and other (*"smaller jobs"*) for customers in mining and minerals industry. Regarding the company services, the two main workforce groups are the mill relining division and a large group of sporadic mine services short term labor.

The company's certification activity is focused on achieving and assuring the service personnel competence quality and safety. In order to meet the customer's minimum site entry requirements for service personnel, the company has to make sure that the personnel has required national qualifications and licenses for work. These include different types of work such as work in confined space, work at heights, and forklift truck work.

According to the manager of site environment and safety (also head of personnel certification activity), the certificates and licenses are something that the customers require: *"As an employer, we need to demonstrate how we train our employees under Australian legislation. Our clients also request this during the tender process."* Nevertheless, the same manager of site environment and safety adds that challenges have occurred: *"The*

availability of some courses can be quite sporadic. Whereas if we had the skills and, knowledge and the training material we could actually do it ourselves. And a bit more cost effective". Therefore, to have the flexibility and a more time-independent way to train courses especially in regards to the sporadic workforce, the company has a registered training organization (RTO) under their company name, in Australia.

This RTO authorizes the company to deliver nationally approved and registered (accredited) training, and issue nationally recognized certificates and licenses to individuals. The RTO has certain scope of registration that comprises the strict content on which they are allowed to train, assess, and qualify. Furthermore, the RTO is responsible to follow the Australian government set standards for national vocational education and training, and the requirements of RTO to continue their registration. In addition to their own employees, the company also provides qualification services for other local companies' employees, adding up to 100-300 individuals trained yearly.

8.1.3 Case A3 - Certification program to support achieving business plans with internal standardization of competence development

The third case A3, also within the company A, concerns a technical services customer support organization in Australia and a personnel certification program comprising both competence development and assessment for the organization's service technicians. The internal certification program was developed recently for the needs of business, and specifically for the competence need of this particular organization and its small and focused workforce group (about 20-30 employees) in one location. However, the program was only recently developed, and not yet implemented at the time of interview. Hence, practical experience from running this particular program was not available. Nevertheless, according to the program developer (the training manager) the same activity was already *"taking place unofficially"*.

The certification program development was referred to as a way of building an internal process to standardize the competence development and to have consistent assessment (according to the training manager). The program was developed to be an internal competence development activity providing a way to control consistency and quality of the process. Furthermore, the program purpose was to describe a standardized and consistent way to develop and perform assessments of service technician competences through four (4) professional performance levels in a planned manner to best serve the business needs achievement. The certification program was based on providing guidelines

for competence development planning, providing training, running assessments, and communicating results in the company.

8.1.4 Case B1 – Certification program to assure competence quality globally in technical services by registration of competences

The case B1 concerned a global technologies and services company based in Finland that had recently developed and implemented an in-house certification program for their 4000 service technicians and engineers in the equipment maintenance services in the company locations globally. According to the project manager for the certification program development and implementation, internal need and the readiness for increasing competence transparency and competence quality between locations, as well as the importance of customer service, drove the company service function to develop their own practice for registration and certification of equipment services competences. The certification program comprises a wide catalogue of service technical competence certificates, and six (6) levels of professional competence roles. These levels were linked to the global job roles of the company.

Furthermore, according to the project manager, the certification program was said to give the company the visibility of their equipment services competences around the world. Earlier the company was missing transparency on what competences existed and in which locations. Before the program existed, the company's skills data was managed on excel sheets and updating skills data was difficult. According to the project manager, the next step in the company competence management will be concentrating on utilizing the personnel certification data for solving the questions related to more efficient competence cross-utilization and resource pooling in order to improve service delivery cost-effectiveness.

8.1.5 Case C1 – Aviation and aircraft maintenance legislation and standards include requirements for competences and verification

The fifth case C1 differed from all the above cases in one particular way. In this case, the organization is a certified aircraft maintenance organization in Finland, and doing business in the aviation field that is strongly regulated by the legislation and authorities. This means that the case organization is obliged for compliance according to external standard requirements. These requirements include among other things that the organization must have qualified personnel working in the aircraft maintenance. The personnel requirements cover competence and training, competence assessment, and recording personnel experience and training.

The requirements for the aircraft maintenance organization personnel include international aircraft maintenance work licenses and aircraft type qualifications that external bodies issue to individuals who want to work in aircraft maintenance. In addition to that, the case organization is also required to ensure and document their personnel competence through internal personnel qualification serving as permit to perform maintenance work for aircrafts, and through internal personnel authorization serving as permit to control maintenance work of servicing whole aircrafts.

According to the interviewed head of compliance control, the competence requirements and criteria for the aircraft maintenance work are quite specifically defined in standard. Based on that, the case organization plans and controls its personnel competence development and provides them with the required training. Furthermore, the training services are purchased from approved aviation and aircraft maintenance training organizations – mainly one local training organization according to the head of compliance control.

In the case C1, organization's maintenance personnel comprise some 350 employees in Finland and contractors mainly in Asia.

8.2 Basis of personnel certification practice

While looking at the reasons behind and the purpose for personnel certification, both external drivers and internal drivers as affecting factors leading to competence assurance and personnel certification in organizations were identified. Furthermore, two separate types of approaches in personnel competence assurance were recognized between the five cases. These were *accredited personnel certification* following an external framework and standards, such as for cases A1, A2 and C1, and *internally standardized certification*, such as for cases A3 and B1. Additionally, there were variations between the cases regarding their scope of certification i.e. the amount and extent of certification activity content and how widely the certification is practiced. These issues are discussed in the following three sub-chapters to evaluate the basis of personnel certification practices in the five studied cases.

8.2.1 External and internal factors affecting personnel certification

Both external drivers and internal drivers as affecting factors leading to personnel certification were identified in the five cases. External drivers represent the needs and reasons for the personnel certification activity being created or that are originating from

outside the company. Analogously, internal drivers describe the needs and reasons being created or that are originating inside the company.

In all the cases the informants mentioned internal drivers, however internal drivers were more important for the internally standardized certification cases (A3 and B1). These internal drivers included certification supporting personnel competence development, gaining competence visibility, meeting business goals, and getting consistency for managing competences and assessment. The final push to start to develop the certification program in the case A3 was the presence of an active training manager; for the case B1 it was the organization overall readiness in the mindset of the management and employees.

For the accredited certification cases (A1, A2, C1) the personnel certification was expected to support the personnel competence development, enhance safety, and provide evidence from the training and assessment. Additionally, for the case A2, qualifying personnel as a registered (accredited) training organization (RTO) resulted in cost savings as they were able to train in-house the same qualifications, that otherwise would have to be purchased from outside, in a more cost-effective and flexible way.

In three cases, the informants mentioned external drivers leading to personnel certification. These cases were A1, A2 and C1 – the accredited certification cases. Furthermore, no external requirements as drivers for the internally standardized certification cases (A3 and B1) were reported. Additionally, if external drivers were mentioned, they were referred to as the dominant driver to pursue personnel certification. The mentioned external drivers included customers, industry, and country. As it was discussed in the case descriptions earlier (chapter 8.1) the industry authorities and customer requirements played an important role in defining the certification at hand. Additionally, a strong certification culture and mindset in Australia became visible from the interviews for the cases A2 and A3. Hence, certification positive environment probably acted as an external driver in the cases A2 and A3 as well. Furthermore, differing from other cases, for the case C1 the aviation and aircraft maintenance legislation was a strong external driver, where the personnel qualification is required by law.

The purpose for running the personnel certification activity in the five cases varied from meeting the external (minimum) requirements for the personnel competence and qualification, to supporting the personnel competence development needs and business goals achievement. Furthermore, the drivers for the accredited certification cases emphasizing external drivers clearly differed from the internally standardized

certification cases focusing more on internal drivers. Nevertheless, the informant in case B1 mentioned about the importance of customer service quality for the organization and how the personnel certification activity was also driven by the earlier received negative customer feedback on the service personnel quality.

8.2.2 Level of control in certification

The level of internal and/or external control used for personnel certification activity to ensure the certification consistency and standardization varied in the five cases. By comparing the cases it was identified that lower control was practiced for the internally standardized certification cases A3 and B1, and relatively higher control for the accredited certification cases A1, A2 and C1.

The lowest level of control emerged as *internally standardized certification* in cases A3 and B1. Here the control was based on providing guidelines, tools and processes. In case A3, the program was based on providing guidelines for competence development planning, providing training, running assessments, and communicating results in the company. Nevertheless, the program was build keeping in mind the Australian national qualification framework and standards. According to the training manager, in this way the program could possibly be later on linked to the external framework and standards, and be externally recognized and valued in Australia. Based on one of the external framework requirements, the plan is to have the trainers and assessors become qualified and accredited by a third party authority in future. As a result from the qualification and accreditation of trainers and assessor, the standardization for conducting training and assessments would be enhanced. Hence, a *qualified and accredited trainer and assessor* can be seen as increasing the level of control in a certification program.

Within the studied cases, becoming an *accredited certification organization* was evaluated entailing the highest level of control. The third party authority accreditation authorizes an organization to provide training and assessment using registered materials under the scope of accreditation. In the case A1, the industry sector authority MQA (Mining Qualification Authority) also registers organization assessors, and audits organization certification activity and quality annually.

Similarly in the case A2, the RTO (registered training organization) is responsible to follow the government set standards for national vocational education and training, and the requirements of RTO to continue their registration. The national standards are there to ensure that the RTO provides training and assessment services that meet the stakeholder,

the framework and the learner needs – as a blueprint to operating with compliance. The standards and requirements include: following the Australian national qualification levels from 1 to 10; following the requirements for training package creation and delivery; using qualified trainers and assessors; and using a standard compliant records management system for documentation and reporting. A governing body for national qualifications accredits the RTO and performs audits every 5 years. Similarly, in the case C1, the aircraft maintenance organization was accredited and accountable to authorities.

Figure 17. illustrates the level of control visible in these five cases, and how the control can be increased to bring consistency and standardization, as well as external recognition and approval, to a personnel certification program. Within the Australian framework, it was also an option for organizations to purchase *accredited training and assessment materials* from external providers as a way to increase level of control; remaining from more extensive accountabilities resulting from being an accredited training organization. This level of control mentioned by the informant in the case A2 was however not identified within the five cases.

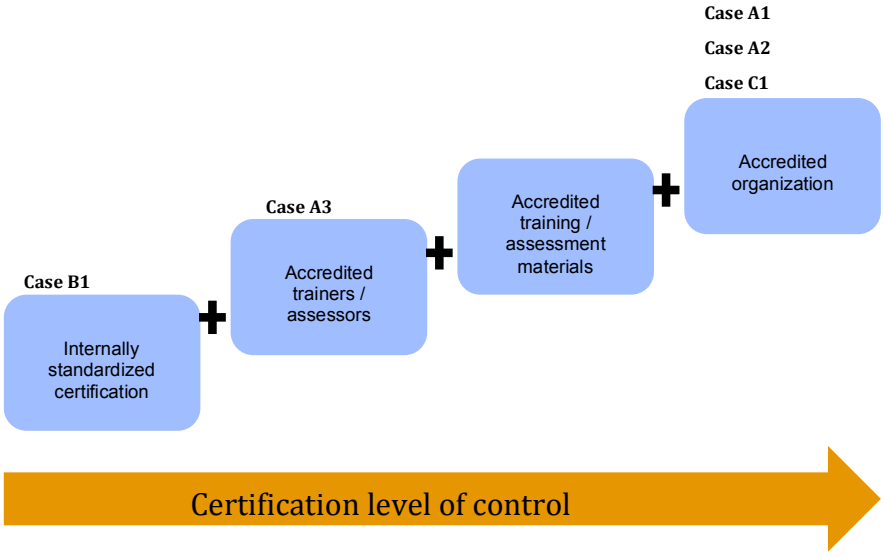


Figure 17. Certification level of control

8.2.3 Scope of certification

The studied cases also varied in the amount and extent of certification activity content and how widely the certification was practiced. Six factors affecting the *scope of certification* in the five cases were identified. These were: employee group in focus (employee group and

number of people); local or global focus; program structure complexity and levels; number of certificates in program; amount and type of competence being certified; and is certification practiced for own employees only or also provided externally as service.

Employees targeted for certification

In all the cases, the employee group in focus of the personnel certification comprised service technicians and engineers, as well as operators for the case A1. These employees perform industrial maintenance service type of work for customer products and plants – on customer sites or company's own premises. For the cases A1 and C1 the focus group included also sub-contractors, and for the case A2 a large group of short term employees in their mine services. In the cases A1 and A3, the amount of employees taken into account in certification was quite limited: 20-30 FSEs to be included in the certification program in the case A3; and 5-10 employees qualified yearly in the case A1. On the other hand, for the case B1 there were 4000 service technicians to consider, and for the case C1 about 350. Furthermore, unlike in other cases, in the case A2 to balance their RTO (registered training organization) maintaining expenses and internal training costs, the RTO also provides training and assessment services to external clients with similar training needs in the local area. Training for externals counts for 30 percent of all their delivered training adding up to 300 individuals being trained and assessed per year. However, according to the informant in the case A2 (the manager of site environment and safety), this ends up to somewhat adding workload for the RTO administrating team.

The case B1 was the only case with personnel focus being global, and all the other cases were focusing their personnel certification activity only locally. However, in the case C1 occasionally sub-contractors mainly from Asia were included in the focus.

Certification program structure

Regarding the program structure complexity and levels, different approaches were visible in the five cases. The internally standardized certification cases, A3 and B1**,** were both focusing on competence roles, and had built their program to be based on professional role levels from service technician to engineer, and in the case B1 further to superintendent. Through competence development an FSE could level up in professional competence roles, but the managers controlled this. These competence role levels were linked to the job descriptions of the FSEs, and hence to organization's business goals. Furthermore, in the case B1, the personnel certification program included a wide training portfolio with both basic product training courses comprising theory and practice, as well

as *"sub-certificates"* that could be acquired through passing a simple checklist assessment assessing service task performance.

The accredited cases A1 and A2 were focusing on certifying single competences, not competence roles. In both cases, organizations utilized the national qualification levels of 1-10 according to which they rank or link their qualifications. For example, in the case A2, their current scope of accreditation comprises resource processing related competencies that also make qualifications on two different qualification levels, namely level 2 and level 3. *"Part qualifications"* are issued for single competence modules and "*qualifications*" for particular sets of competence modules in both cases A1 and A2.

Similarly to the cases A1 and A2, the focus in the case C1 was on certifying single competences. The case company was utilizing competence categories of A, B, and C from the standard for aircraft maintenance personnel competence requirements including both technical competence, and competence in *"human factors"*. Training courses with theory and practice were purchased from an approved training organization, but maintenance task performance certification was done internally. *"A-category"* certificates in the case C1 were issued similarly to the *"sub-certificates"* in the case B1 – through acquiring single competence e.g. single particular maintenance task.

In all the cases, except for the case A3, the organizations were issuing certificates for individuals per acquired competence module and for acquiring a group of competence modules. In the case A3 (where the certification program was only recently developed), the certificates were planned to be issued only after acquiring all competence modules required for particular level "*competence profile"*.

The certificate catalogue size varies case by case. In the case A3, there are only 3 competence level certificates. On the other hand in the case B1, the number of certificates and sub-certificates was *"huge"* according to the interviewed project manager for the program development and implementation. Furthermore, in the case C1 the interviewed compliance control manager explained that previously the company was performing their certification model in a heavier way. Earlier, the company had altogether some 250 different certificates (qualifications and authorizations) internally in use. However, the company was currently undergoing their model revising, and the new certification model for qualifications and authorizations was planned to comprise only 27 qualifications and 11 authorizations.

According to the manager of site environment and safety, a similar situation had happened earlier in the case A2 as well. First too many qualifications and competence units were included in the scope of the RTO accreditation, but eventually the scope had to be reduced due to the administrating and maintaining challenges, and lack of resources. Nevertheless, the case A2 was at the time of the interview planning additions to their scope, as the company had recently developed three qualifications for mill relining. This was because the mill lining competence is company's core competence and such qualifications did not exist previously in Australia. So far the case A2 scope comprised 2 qualifications and 11 units of competence. Regarding the case A1, further details on the certificates were not available.

FSE competence being certified

In the five cases, the FSE (field service engineer) competence that was being certified was mostly focused on technical competence, however non-technical FSE competences were considered as well in few cases. In the case A1, for example, the scope is only technology focused on operator qualification (other details were not available).

In the case B1, the approach is similarly very much concentrated on technical competence i.e. on company equipment and technology, and on equipment services comprising installation, commissioning, maintenance, and overhaul and repairs. Additionally, one internal EHS (environment, health and safety) course is included in the program scope in case the B1. Other non-technical or soft skills are not included. However, feedback on the importance of including soft skills and language skills to the certification program has been reported, and according to the project manager (informant in the case B1), external industry related certificates regarding e.g. work in heights and hot work, and local safety certificates will be integrated to the program later on to give a full overview on individual competences and certificates.

In the cases A2, A3 and C1 relatively more importance was given to the FSE non-technical competence in addition to technical competence. In the case A2, competence included in qualifications comprised work safety, control and quality knowledge and environmentally sustainable work practices, as well as workplace communication. In the case A3, in addition to the safety and communication competence, the ability to apply company values and customer focus was required from the FSEs. In the case C1, the competence on "*human factors*", such as work safety, environment, as well as communication and teamwork, were included in the maintenance personnel competence requirements by law.

Based on the five cases, both technology and product specific competences, and non-technical competences were included in the certification programs. The technology and product specific FSE competences comprised installation and commissioning, maintenance such as inspection and replacement, repairing, operation (in the case A1), supervision, and special tasks (B1, C1). The non-technical FSE competences included the QEHS (quality, environment, health, safety) policies and procedures, workplace communication, teamwork, company values (A3), and customer focus (A3). (See table in Appendix 3. for details.)

Figure 18. illustrates the extent of the scope of certification in the five cases, and the identified six scope factors. These findings are based on the data analysis on how narrow or wide the scope for certification program is regarding each scope factor. Decision on whether the scope factor is narrow or wide is based on comparing the cases to each other, and based on how many factors the case at hand scores as being narrow or wide. (See table in Appendix 4. for further details.)

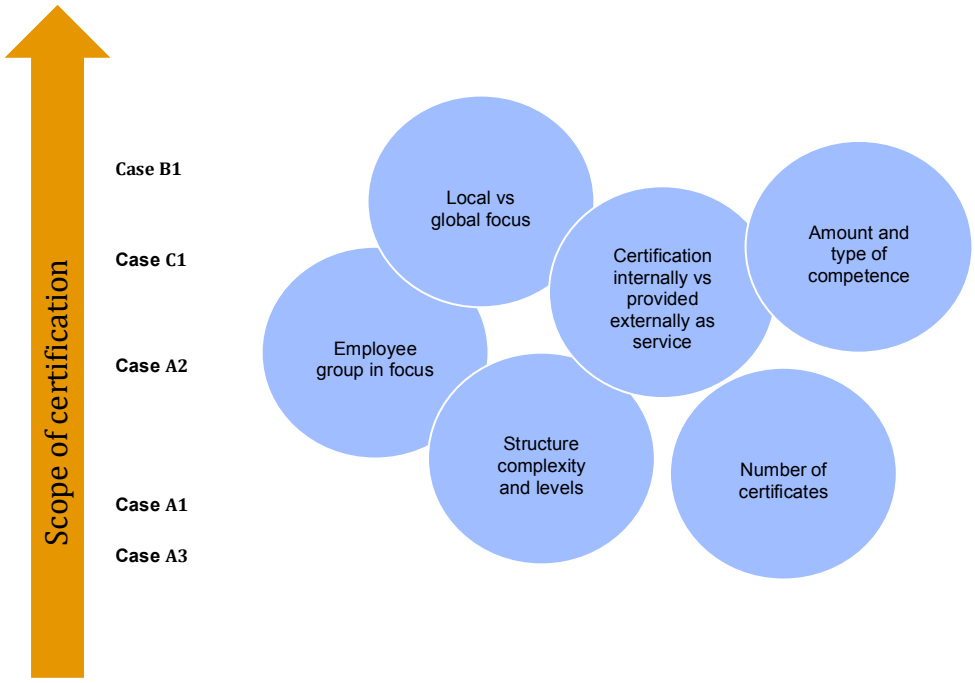


Figure 18. Scope of certification

8.3 Running personnel certification program

The personnel certification programs were run quite similarly to each other in the five cases, however differences were identified as well. The findings from the cases regarding

the certification process, and the resources that were utilized to develop, implement and run personnel certification, are reviewed next.

8.3.1 Process in certification

Figure 19. illustrates the personnel certification process from the studied cases. There are four basic process steps visible in all five cases: initiation for competence development and certification, competence development, competence assessment, and certification.

In the *initiation* phase mostly the line managers are responsible for initiating the process. The line managers assign competence roles and related competence requirements for the FSE (field service engineer) (B1), or the line managers request training and qualification for the employee as in accredited certification cases (A1, A2, C1). In the case A3, the FSE is responsible for initiating the process themself by identifying the competence possessed by certification role levels and further following to the pre-assessment step for detailed self-assessment and being assessed by the line manager (see step 2 in Figure 19.).

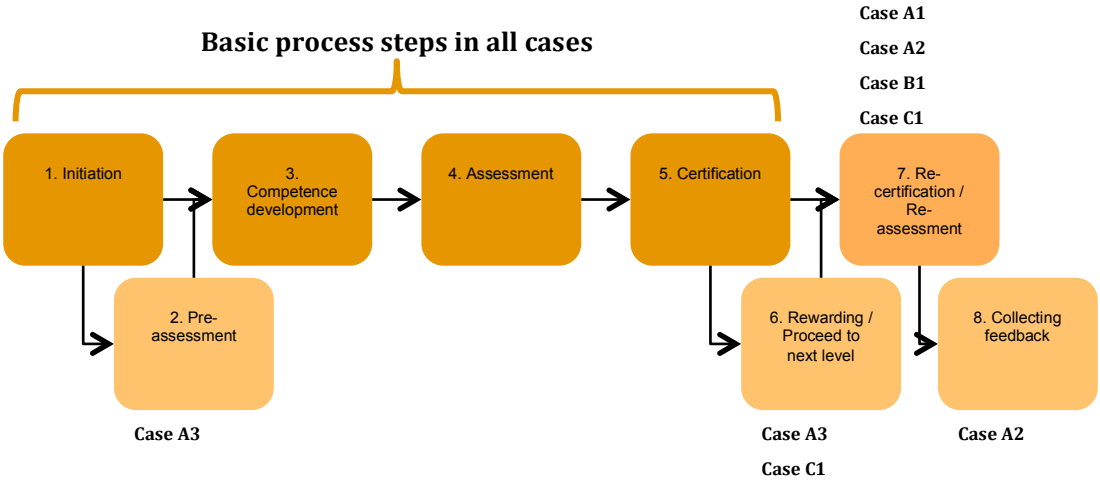


Figure 19. Certification process steps

The next step, *competence development*, comprises off-the-job training for all the five cases, but also on-the-job training is included in four out of the five cases. In the case B1, this step consists of both training courses – either instructor-led or in the form of an e-learning. Furthermore, on-the-job training (*"OJT"* in the case B1) is either in the form of work or in the form of an arranged training event offering the opportunity to learn certain maintenance tasks for example in the presence of a senior colleague. In the case C1, the

company purchases training courses from an approved training organization. These courses are in the form of theory training, or both theory and practical training. Additionally, the competence development step in the case C1 comprises supervised on-the-job practicing for maintenance tasks.

Similarly to the cases B1 and C1, in the case A2, the training courses comprise both theory and practice. However, the practical training is performed with simulation equipment. According to the training manager from the case A3, there are also plans to have both off-the-job training and on-the-job training. However, no further details were available on how the training would actually be delivered and by whom. Different from other cases, in the case A1, the industry authority requirements are demanding only theory training by a MQA (the Mining Qualification Authority) registered trainer, and hence particular on-the-job training or practical training is not included in their personnel certification.

Competence *assessment* follows the competence development step in all the five cases. In the case B1, the training courses include end exams, and other assessment is online assessment via multiple-choice questions and *"OJT"* assessment. The *"OJT"* assessment is based on a checklist and performed by a senior colleague or a manager. The task performance assessment in the case C1 is run similarly and is based on maintenance task manuals. Both the duty manager and the quality engineer are conducting the task performance assessment together in the case C1.

In the case A1, the theory training includes an end exam as the assessment requirement of the MQA (the Mining Qualification Authority). However, the organization has independently included an internal practical field assessment as additional assurance of personnel competence. This practical assessment is continuously taking place on site, as a *"plant task observation"* (PTO), and conducted as peer assessment. Focus personnel group of the PTO has been mainly operators. Furthermore, according to the informant in the case A1 (the manager of safety, health and environment), the conducted PTOs in operation and maintenance environment have also resulted in valuable feedback to company's engineering, and revising their operating manuals. In the case A2, varying methods from paper based assessments to having the FSE demonstrate their competence with simulator equipment is utilized.

After the FSE competence is trained and assessed the certificate can be issued. In the *certification* step in the five cases the FSE is recognized competent based on records from training and assessment. In the internally standardized case B1, the certificate is

issued in company's learning management system (LMS). In the accredited cases A1, A2 and C1, the certificate for qualification is issued by the company CEO, or by the registered training organization, and records are transferred to external authority databases as well.

Some additional steps following the certification process step are included in few of the cases. In two of the five cases (A3, C1), the certification is followed by some level of *rewarding* (see step 6 in Figure 19.) that was linked to the level progression in the personnel certification program or to the FSE salary and bonuses. In the case A3, the level progression demands hundred percent of the required FSE level competences to be acquired plus sufficient performance records. In the case C1, the certification is linked to the FSE salary, and bonuses are granted for special qualifications.

Most of the cases include a *re-assessment / re-certification* step as well (see step 7 in Figure 19.), with the exception of the case A3. In the accredited cases A1 and A2, the issued qualifications are valid forever, however both organizations are internally practicing re-assessment and re-certification via workplace on-the-job assessment (PTO in the case A1) against initial competence criteria, or theory refresher courses. This step is conducted every few years, when necessary, or continuously like the PTO. In the aircraft maintenance case C1, the maintenance personnel is required to take continuation training every 2 years to keep certification.

For the internally standardized case B1, the company had decided that certificates are valid for 3-5 years. Some time prior the certificate expiration, an automatic email notification is sent to the FSE and an online assessment is required. If the certificate expires, full training and assessment will be required.

The case A2 additionally has a separate process step for *collecting feedback* from the trainers, assessors, program participants, and other stakeholders (see step 8 in Figure 19.). The accrediting authority requires this feedback collection.

8.3.2 Resources in certification

The resources utilized in a personnel certification program based on the findings from the five cases are illustrated in Figure 20. The resource factors present in the five cases are discussed below.

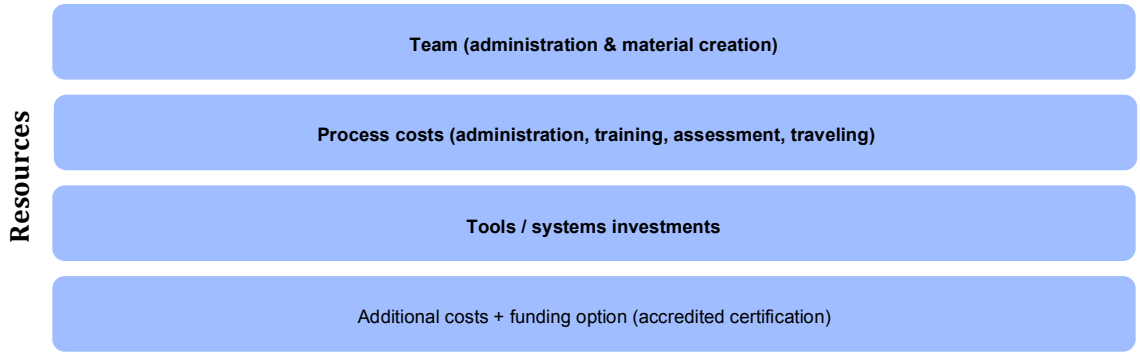


Figure 20. Resources for certification

Administration and material creation team

In general, for all the five cases the administration and maintenance *"team"* comprises 1-2 employees, program manager and/or training manager, regardless of the scope of certification. The case C1 is an exception where the compliance control team comprises 8 employees. Nevertheless, they manage the compliance control issues regarding the whole aircraft maintenance organization, and not only personnel competence related.

Especially for the accredited cases A1 and A2, the certification scope (and scope of registration approved by the external authority) strongly affects the amount of work required to run the certification program and to provide training. According to the informant in the case A2 (the manager of site environment and safety), running an RTO is heavy on administration and maintenance. Also the lack of trainers is noted as a problem in both the cases A1 and A2. In the case A2, the company originally started with a larger scope, but had to cut some content due to the lack of resources.

In the internal case A3, all activities were planned to be run by the FSE themselves and their managers by utilizing the available tools and processes – with the support from training manager, service work coordinator, and qualified assessor. The case B1 differed here a little by having the line managers mainly to run the certification process, while training function and portfolio experts (subject matter experts) manage the personnel certification program administration and maintenance.

Regarding the certification program development, the internal cases A3 and B1 provided some insight. In the case B1, the certification program development phase and creating the original content and material was done by the program development team. The team consisted of project manager, competence experts, and members from company's training

organization. In the case A3, the program scope was significantly narrower and the program was developed mainly by the training manager (the informant in the case A3) with the help of organization manager and technical competence masters.

Process costs

The process costs for the personnel certification result from arranging and delivering training and assessment, and from possible related traveling expenses. Additionally, the process costs also comprise the hidden cost of time of the people involved in the certification process steps: e.g. time of the FSEs, managers, or senior colleagues acting as trainers, assessors or supervisors.

Unlike in the internally standardized cases, the trainers and assessors in the accredited cases A1 and A2 were registered and qualified by an external authority. However, outside their scope of accreditation, or when lacking a trainer or assessor, in the case A2 the RTO (registered training organization) has to arrange external training for their workforce to meet the certification requirements. This further adds up to the process costs. In the case A1 the informant (the manager of safety, health and environment) stated as well, that the lack of trainers and assessors was an issue.

Tools and systems investments

In the accredited cases A1, A2 and C1, the accrediting external authority (and standards) had set requirements for personnel certification data management as well. For the cases A1 and A2, an approved records keeping system and/or training management system is in use to build courses, enroll trainees, collect and store evidence, print certificates or other outcome documents and reports. The system is also linked to authority's system. In the case A2, the RTO has both records keeping and training management systems in use. For the company in case C1, the personnel certification data is mainly stored in the management system of the external, approved training organization, and some data is stored on paper in the company's own archive.

In the internal case B1, investments in tools and systems for the FSE personnel certification program comprised developing a wide certificate catalogue, and developing in-house tools for online assessments and competence search. In the case B1, the company already had an existing learning management system (LMS) that could be used for master data and certificate records, and registration for training and assessments.

Additional costs for accredited certification cases

For the accredited case A2, also the training and assessing material requirements controlled by the authority create some fluctuation in costs annually. There were material purchasing, revision and updating costs involved. However, according to the informant in the case A2 (the manager of site environment and safety), the RTO manages to operate somewhat cost-neutral as it is also offering certification services to externals.

In the cases A1 and A2, possibility for receiving various funding existed as well. However, at least in the case A2 according to the manager of site environment and safety, this was said to require extensive reporting, and therefore not yet taken advantage of. In the case A1, in South Africa, the organization was receiving refund from personnel development, and tax refunds for the BEE (Black Economic Empowerment) policy compliant activities.

8.4 Experiences from personnel certification in industrial maintenance services

The experiences based on the five cases from both developing and implementing the certification programs, as well as from running the certification programs are reviewed below.

8.4.1 Assumed and experienced benefits

The internally standardized certification cases (A3, B1), were experiencing internal efficiency and quality assurance on the service work and the FSE competences as the most mentioned benefit by the informants. Furthermore, in the case A3, the interviewed training manager was assuming also that competent and certified FSE, and marketing the "certified FSE" in service sales, would bring competitive advantage in the future and result in new service leads that increase business.

In the accredited certification cases (A1, A2, C1), internal efficiency and quality assurance on the service work and the FSE competence were also perceived as benefits. Additionally, in these accredited cases, assurance on the work safety and the legally valid evidence produced from training and assessment records were experienced as great benefits. In the case A1, there had already been an incident where the personnel training and assessment records were used advantageously as proof in a legal conflict situation for the benefit of the organization. In the case C1, running personnel certification was one requirement for the business, and hence the main benefit resulted from having the permit for running an aircraft maintenance organization in the first place.

From the employee perspective, the interviewed informants assumed that personnel certification would provide the FSEs benefits such as recognition and motivation as their competence was being acknowledged and developed. In the accredited cases the qualifications were valuable also outside the company. One informant, from the case B1 also assumed that personnel certification would enhance the equality between the FSEs in the company in general. Furthermore, few cases (A3, C1) had included employee rewarding in their certification processes (see chapter 8.3.1).

Benefits for the customers were mainly evaluated by the informants as the increase in customer service quality resulting from the FSEs being more competent for the maintenance service work. In the accredited cases (A1, A2), the personnel certification was something that the customers required, so the certification activity was much about meeting the customer's expectations in the first place. Furthermore, according to the informants in these two accredited cases (A1, A2), following an external certification framework that was valued and visible to the customers provided transparency on the certification activity to the customer's also. Additionally, in the case A2, the customers are also receiving reductions for their insurance costs if they are purchasing their service from companies with qualified FSEs, in Australia. Hence, qualifying the FSEs can result in cost savings for the customers' as well.

8.4.2 Experienced challenges

Most challenges in all the five cases were experienced in creating the certification program, its content, materials and tools, administrating and maintaining the program, and finding the resources. Several cases were also reporting challenges with insufficient and not optimal management systems for their personnel certification program data management. Additionally, the change management was seen as challenge especially in the internally standardized cases (A3 and B1).

The accredited certification cases (A1, A2, C1) had encountered challenges especially regarding the scope of certification and how many qualifications to include in their scope. This was because the resource requirements increased with the scope. The cases A2 and C1 had already experience on having to reduce the scope. Also, getting externally recognized trainer/assessor qualifications for existing trainers and assessors working within organization was seen as a challenge in the accredited cases.

Additionally, in the case C1, the informant also mentioned that their previous approach to competence development as a time-based had become outdated and would be

transformed into a competence-based competence development – i.e. in future the certification would not be dependent on the amount of time the individual has practiced certain maintenance task, but as soon as the individual was recognized competent he/she would be qualified.

In the case B1, during the program development, the creation of a harmonized global certification program and developing a certification catalogue had been challenging and resource intensive. The interviewed project manager in the case B1 also mentioned that especially the development of the assessment materials had been surprisingly demanding, and should have been made in a stricter manner in the first place. During the program implementation there had been negative feedback already on the assessment materials' weaknesses and shortcomings. This had resulted in the need to redo parts of the assessments.

Some other challenges, not highly outstanding and not directly related to the development or running a personnel certification program, were mentioned as well. These included e.g. negative employee attitudes, culture differences in the attitudes towards personnel certification, lack of organization maturity for personnel certification, and poor FSE language skills creating challenges e.g. in conducting formal training and assessments.

8.5 Approaches to FSE certification

The following sub-chapters summarize the multiple case study findings in a framework, and further discuss the alternatives to FSE certification based on the research findings.

8.5.1 Summarizing multiple case study findings

The findings from the conducted multiple case study assume that certain drivers, both internal and external, affect the FSE personnel certification. Especially the external drivers seemed to be dominant in resulting in personnel certification accredited by an external third party authority. At the same time, internally standardized personnel certification was resulting from the internal drivers, and no external drivers were reported.

Four main elements in the FSE personnel certification were identified in all the five cases. These main elements comprised level of control in certification, scope of certification, certification process, and the resources needed in certification. The control and scope elements in the FSE personnel certification varied more between the cases, as the process and resources elements in the studied cases were more in line with each other. The

adopted process and resources elements were mostly resulting from the control and scope elements of certification.

The experienced and perceived outcomes from the FSE personnel certification included both benefits and challenges. The studied cases had both similar and differing experiences from the FSE personnel certification. Regarding the internally standardized certification cases, the benefits were mostly assumed and anticipated benefits, or both the benefits and the challenges were primary experiences from the program development and implementation. Figure 21. summarizes the multiple case study findings.

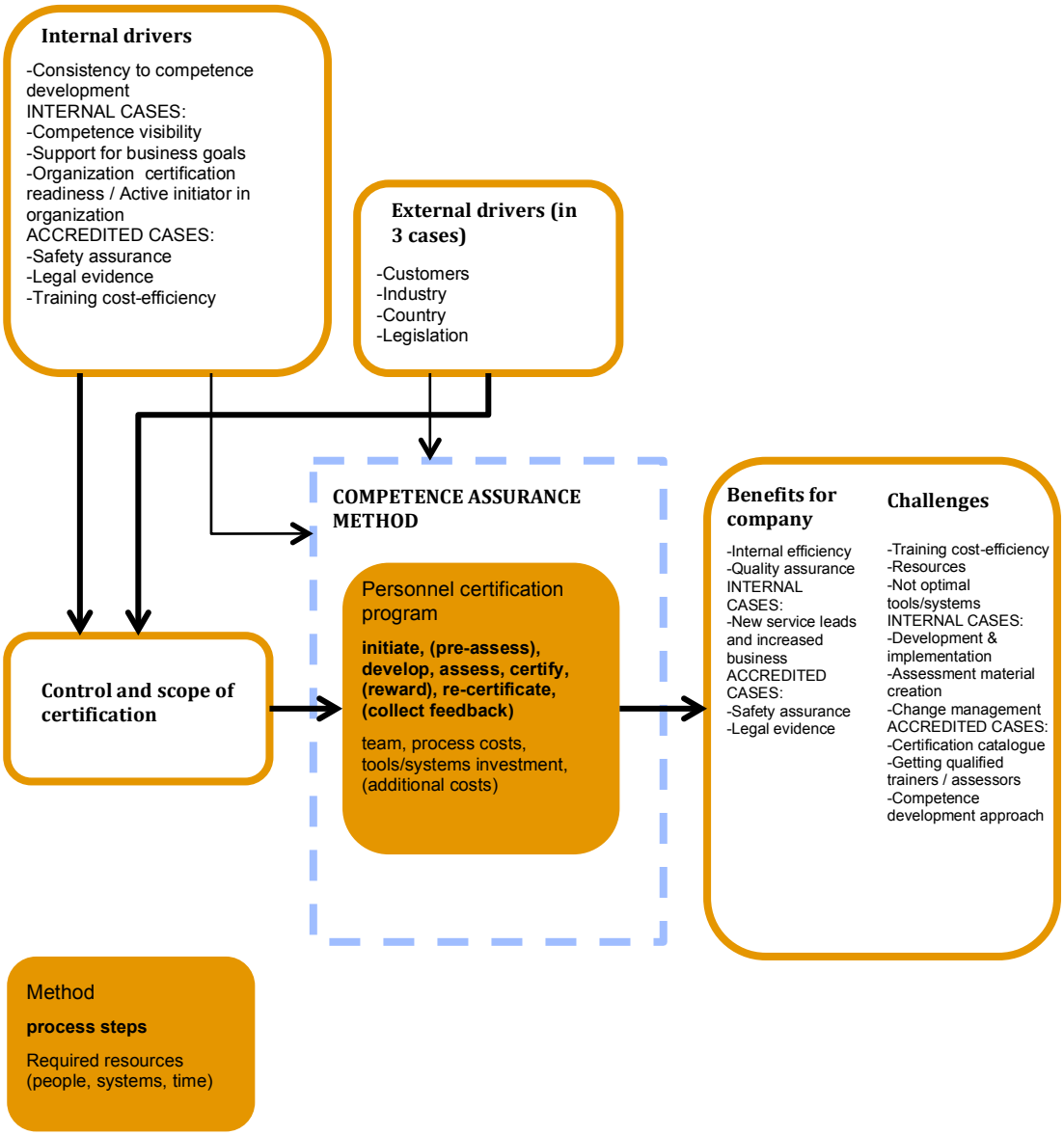


Figure 21. Multiple case study findings: FSE personnel certification

8.5.2 Alternatives to FSE certification

The multiple case study findings anticipate that there are two distinct approaches to FSE personnel certification taking place in practice: accredited certification and internally standardized certification. These approaches especially relate to the control element identified in the five cases, which varied from low to high amount of control practiced in the FSE personnel certification activity.

On the other hand, also the scope element created variation between the studied cases. Scope of certification in the five cases varied from narrow to wide, and the chosen combination regarding the six identified scope factors from analysis further determined, together with the control element, the way the FSE personnel certification was run.

Figure 22. illustrates the alternatives for approaching FSE personnel certification based on how it was visible in the conducted research. Each of the five cases can be further identified in the matrix in Figure 22. Roughly, the case A3 can be identified to the left lower quartet (low control - narrow scope), the case B1 to the left upper quartet (low control - wide scope), the case A1 to the right lower quartet (high control - narrow scope), and the cases A2 and C1 to the right upper quartet (high control - wide scope). Note that the matrix in Figure 22. does not reflect the studied cases in detail, but merely gives a summarized outlook to what factors affected the personnel certification control and scope.

Figure 22. Alternatives to FSE certification focus (based on findings from cases)

9. DISCUSSION

This chapter concludes the thesis summarizing the literature review in relation to the findings from the multiple case study, and further discussing the research findings. First, answers to the research questions are derived from the theory and empirical findings, and the thesis findings are concluded. Next, managerial implications and contributions to existing literature are considered. Finally, the limitations of the study and suggestions for further research are discussed.

9.1 Research summary

9.1.1 Answering research questions

The objective for this research was to study if personnel certification is beneficial for companies in industrial maintenance services, and in assuring field service engineer (FSE) competence especially. Motivation for this study originated from the company A's interest and challenges related to a problem on how to solve the need to assure the competence of their FSEs dispersed in various locations globally. Furthermore, the company A saw some form of personnel certification as an attractive option.

The research was carried out as a multiple case study examining five organizations globally, and their maintenance service personnel certification activity. Also related literature was researched. The three research questions that were formulated based on the objective for this study are answered below.

Competence assurance methods and key elements (RQ1)

The first research question concerned what kinds of methods existed for personnel competence assurance in companies, and furthermore, what were the key elements there.

Literature on competence assurance methods taking place in companies was basically not found. From the intellectual capital (IC) management field, methods for competence management and development were reviewed (Bergenhenegouwen et al., 1997; Athey & Orth, 1999; Drejer, 2000; Dalkir, 2005; Suikki et al., 2006; Ellström & Kock, 2008; Otala, 2008; De Vos et al., 2011), where emphasis was much on competence development solely and not on formal assessment and assuring the personnel competence. The competence development practices in companies were said to comprise determining and defining

competences, developing and maintaining individual competences, and monitoring effects of competence development (Bergenhenegouwen et al., 1997).

With the challenges of finding examples of actual competence assurance methods in the company context, few possibilities from other fields than IC and competence management in companies were reviewed from the literature. Quality assessment from education field was one (Biggs, 2003; Newstead, 2003; Baartman et al., 2006; Joosten-ten Brinke et al., 2007) and comprised key elements of selecting assessment criteria, selecting evidence for making the assessment, and making judgment based on the criteria and evidence (Biggs, 2003, p.161).

Professional certification for industrial maintenance personnel was another reviewed competence assurance method (Wiley, 1995; Lysaght & Altschuld, 2000; EN ISO/IEC 17024:2012), where person certification is conducted by an external approved third party, and based on standardized assessment. Professional certifications for maintenance personnel especially were found to be offered at least in Europe, the U.S. and Canada (CEN/TR 15628; EFNMS-a; EFNMS-b; SMRP-a; SMRP-b; PEMAC; Inspecta). Nevertheless, these professional certifications for maintenance personnel were used in none of the studied cases, and furthermore, certificates offered by external parties were criticized for focusing only on testing theory, and not having emphasis on actually assessing practical competence required for work (Robertson, 1999). Informants from the multiple case study shared similar views.

However, from the literature one example of a fully in-house personnel certification program was found (Robertson, 1999). This method combined both competence development and competence assessment into one program in company context. The key elements for this method comprised performing competence analysis, developing competence, assessing competence, communicating results from assessment, conducting re-certification later on to maintain competence, and rewarding individuals (Robertson, 1999).

Two of the studied cases (A3 and B1) were very much similar to the in-house certification program example from literature (Robertson, 1999). In these two cases, the organizations' certification activity was internally standardized. The three other cases (A1, A2, C1) were practicing accredited certification approved by an external authority, and were linked to an external framework and standards. However, personnel certification, in all the five cases that were studied, was run in-house. Nevertheless, the *level of control on certification*

and the *scope of certification* varied between the five cases, and for the accredited certification cases the level of control was higher than for the internally standardized certification cases.

The drivers for running personnel certification activity in the five cases varied from meeting external requirements for the personnel competence and qualification (originating from customers, industry, and country) to supporting personnel competence development needs and business goals achievement as internal drivers for certification. Based on the five cases, the external drivers were perceived as dominant, and when present, they seemed to lead to accredited certification.

As a result from the multiple case analysis, the *control* and *scope* elements that were identified in the cases seemed to result in certification activity with certain *process* and *resources* that were needed in order to run (and develop and implement) a certification program. The *certification process* comprised the following four (4) basic steps in all the five cases: initiation (and pre-assessment), competence development, competence assessment, and certification. Depending on a case, further steps were included such as rewarding, re-certification, and collecting feedback. This same structure in the process steps was present in the in-house personnel certification example from the literature (Robertson, 1999), and also comprised parts from the competence development practices, the educational field assessment, and the professional certification frameworks reviewed from the literature (Bergenhenegouwen et al., 1997; Biggs, 2003; EN ISO/IEC 17024:2012).

Certification resources in the five cases comprised a team for administration and material creation, process costs (from administration, training, assessment, and possible travelling expenses), and investments in tools and systems. The certification teams usually comprised 1-2 employees (program manager and/or training manager), and varying support and time of the subject matter experts, managers and employees. Literature on competence development further adds human resources (HR) as a resource group in competence development activities in companies (Otala, 2008, p.94; De Vos et al., 2011), and the professional certifications and the in-house certification example emphasized the role of assessors and the need for having certified assessors (Robertson, 1999; EN ISO/IEC 17024:2012). Similarly, in all five cases, except for one (B1), the trainers and assessors were certified or qualified. This was either requirement from an external authority for accredited certification, or result from the need to increase the level of control and enhance reliability and credibility for internally standardized certification program.

Personnel certification requires also investments in tools and systems for managing all the data from competence development and assessment. In the accredited cases (A1, A2, C1), certain systems were included as requirements of external framework and standards. In general, different training, learning, and data management systems were utilized. For the accredited certification cases some additional costs related to using registered training materials was included, but also option for funding from external authorities for employee competence development existed.

Furthermore, measuring the impact from competence development and competence assessment resulting from certification program was not emphasized in the studied cases. Only one accredited certification case (A2) was collecting feedback from various stakeholders to improve their certification activity resulting from external requirements. In the in-house certification example from the literature (Robertson, 1999), measuring the impact from personnel certification was referred to as being difficult but highly recommended to make sure that the certification program is serving the needs of business.

To summarize, based on all the five cases, and based on the literature review, personnel competence assurance methods share a common important and inherent characteristic, that confidence in the competence assurance program or activity is achieved by means of an accepted process of assessment of the competence of individuals (ISO/IEC 17024:2012:E). For example, EN ISO/IEC 17024 international standard for all certification of persons provides principles and requirements for any body or organization conducting certification of persons. The use of standard enhances consistency, comparability and reliability between all individual certification (ISO/IEC 17024:2012:E). Furthermore, a framework of 12 quality criteria developed for competence assessment programs specially consists of: authenticity, cognitive complexity, meaningfulness, fitness for purpose, fitness for self-assessment, fairness, transparency, educational consequences, reproducibility of decisions, comparability, cost and efficiency (Baartman et al., 2006). All this emphasizes that personnel certification and competence assurance, in order to be valued and trusted by all stakeholders, must be based on commonly accepted practices and processes.

Perceived FSE certification benefits for company, employees and customers (RQ2)

The second research question asked if personnel certification in industrial maintenance services is perceived beneficial for the industrial services company, for the company employees (FSE), and for the customers as well.

From the literature, actual experiences and evidence on practices in companies, and benefits and tradeoffs related to personnel certification were no found. Furthermore, the literature review indicated that competence assurance in company context competence management practices hardly exists. However, the benefits reported in the literature reviewing few assurance methods included: gaining proof of individual's competence and assurance that individual is qualified for their job; motivation and boosting for employee's career; and increased credibility and trust in the eyes of a customer (Wiley, 1995; Lysaght & Altschuld, 2000; Biggs, 2003, p.141; Newstead, 2003).

The professional certifications especially were said to provide credibility and trust as the individual is approved by a reliable and impartial third party authority (Wiley, 1995; Lysaght & Altschuld, 2000). However, an in-house approach to certification was also claimed to provide this evidence for the customers (Robertson, 1999). Furthermore, benefits of an in-house personnel certification over an externally provided professional certification was that the competence development and testing would be based on company's own internal standards and critical focus on testing the hands-on expertize could be included unlike in professional certification (Robertson, 1999).

The conducted multiple case study provided evidence that personnel competence assurance is indeed practiced in industrial maintenance service companies for their maintenance service personnel (technicians and engineers). The internally standardized certification cases (A3, B1) were experiencing internal efficiency and quality assurance on the service work and the FSE competences as the most mentioned benefit according to the interviewed informants. Furthermore, the informants in these cases were assuming that competent and certified FSE, and marketing the "certified FSE" in service sales, could bring competitive advantage as well, and result in new service leads that could increase business. However, these two internally standardized certification cases were only recently developed or implemented, hence the experiences from running the certification program lacked. For the accredited certification cases (A1, A2, C1) assurance on the work safety and the legally valid evidence from the training and assessment records were also experienced as great benefits.

Regarding the employee perspective, the informants assumed that the personnel certification would provide the FSE personnel with the benefits such as recognition and motivation as their competence was being acknowledged and developed, as well as enhance the FSE equality in the work environment. Additionally, for the accredited cases

(A1, A2, C1) the FSE qualifications were also valuable outside the company at least within the country of the case.

According to the case informants, benefits for the customers were mainly assumed as the increase in the service quality as the FSEs would be more competent for the maintenance service work. However, in the accredited cases (A1, A2, C1), the FSE certification was much about meeting the customer's expectations. In one accredited certification case (A2) in Australia, the customers were also said to be receiving reductions for their insurance costs if they were purchasing service from the companies with qualified FSEs delivering the service.

Most of the challenges in all the five cases were experienced in creating the certification program, its content, materials and tools, administrating and maintaining the program, and finding resources. The literature review also already indicated that integrating competence assessment practices into a competence program comes with significant time and resource tradeoffs (Baartman et al., 2006; Joosten-ten Brinke et al., 2007), and requires meeting the assessment quality requirements (Baartman et al., 2006). Several cases were also reporting challenges with insufficient and not optimal management systems for their personnel certification program data management. Furthermore, the change management was seen as a challenge especially in the internally standardized certification cases (A3, B1). This could be resulting from the absence of an external, established and valued certification framework that could increase the program credibility and acceptance to the various stakeholders from the very beginning. In the accredited certification cases no change management challenges were mentioned by the informants.

In two of the accredited certification cases (A2, C1), the scope of certification had been originally too wide, and they had ended up having to reduce the scope. Also, getting qualified trainers and assessors was experienced as a challenge in all the accredited certification cases (A1, A2, C1). Some other encountered challenges included: realizing that originally used time-based approach to competence development had become outdated and needed to be transformed into a competence-based approach; negative employee attitudes; culture differences in the attitudes towards personnel certification; lack of organization maturity for personnel certification; and poor FSE language skills creating challenges for example in formal training and in assessments.

From both the literature and the multiple case study, the benefits as well as the challenges were either lacking or much focused on the program development and implementation

phase experiences, except for the few accredited certification cases. Furthermore, the experiences from the studied cases were mostly based on assumptions and perceptions of the interviewed case informants.

Evaluating FSE competence that is critical to assure and methods for that (RQ3)

Finally, the third research question asked for how do we evaluate what field service engineer (FSE) competence is critical and how it should be assured.

Based on the literature review it was evident that FSEs and their competence are critical in creating the service quality and competitive advantage in industrial maintenance services (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Mathieu, 2001). Some FSE competence requirements were discussed in the literature, where both technical and other competence (e.g. environmental constrains, quality control, health and safety, problem-solving, team dynamics) were emphasized (Nguyen, 1998; Tsang, 2002; Kutvonen, 2012). Additionally, FSE's reliability, responsiveness, empathy, clear communication, and credibility were recognized having a strong impact on customer perceived service quality (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Nguyen, 1998; Peterson et al., 2004; Kutvonen, 2012), and therefore these soft (or relational) skills can be seen as critical requirements for the FSEs and their competence.

The standards and professional certificates from the literature review provided also some generic reference for benchmarking the FSE competence requirements. From CEN/TR 15628 maintenance personnel qualification standard, the FSE requirements include both task related competences and general competences. Task related competences comprise performing technical maintenance service and maintenance tasks for products and plants including also competence requirements e.g. for law and regulation and documentation (CEN/TR 15628:2007:E). General competences entail company environment, work planning, teamwork and communication, English language, information technology, training and instructions, quality assurance, environment, and automation competences (CEN/TR 15628:2007:E). However, the FSE competence requirements from standards and professional certificates remain quite generic. This is assumed to result from the need to keep the offered professional certifications suitable for employees in different companies doing maintenance service business in varying industries. Too detailed professional certifications especially regarding the technical issues in task related competences might contradict too much with companies' own technologies, or the technologies and equipment being serviced.

In the studied cases, the FSE competences being assured and certified in practice included both technology and product specific competences, and non-technical competences. The technology and product specific FSE certified competence comprised installation and commissioning, maintenance such as inspection and replacement, repairing, operation (case A1), supervision, and special tasks (cases B1 and C1). Further, the non-technical FSE certified competences included QEHS (quality, environment, health, safety) policies and procedures, workplace communication and teamwork, company values (case A3), and customer focus (case A3).

Unlike in the literature (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Nguyen, 1998; Peterson et al., 2004; Kutvonen, 2012), in the five studied cases, the soft (or relational) skills of the FSE were not mentioned or said to be regarded for the personnel certification program. This might be assumed to be caused by following reasons: in the accredited certification cases the external authority and the certification framework and the standards did not include soft (or relational) skills in their requirements and hence, these skills might not have been considered or thought of; the internally standardized certification cases were both recently developed (and implemented), and for the time being the primary focus in these cases was clearly given to the more operationally critical FSE competence (knowledge and skills) required to perform maintenance service successfully. Furthermore, it should be argued that even though the reviewed literature emphasizes the soft (or relational) skills as being critical for the FSE competence, it remains undiscussed whether this type of competence should even be assessed or assured. The soft (and relational) skills might be something that is more related to the individual's characteristics, and not considered as something to be trained, assessed, or certified.

Furthermore, all the five cases emphasized the importance of practical assessments in assuring FSE competence. Various maintenance task performance assessments were utilized, and conducted either under supervision or performing service on simulation equipment. For one accredited certification case (A1) the external framework assessment requirements were evaluated by the organization itself as not being sufficient to assure the competence of their FSE personnel. Hence, that organization had developed own additional practical assessment. Therefore, it seems that organizations have a special need to check the actual knowledge and skills of their maintenance personnel and that they can really perform maintenance on equipment and in plants in a correct manner. This might be a result from different issues such as unsuccessful maintenance in the past or negative customer feedback on delivered maintenance service.

To conclude, standards from the literature review provide some generic reference for benchmarking the FSE competence requirements and what is evaluated as critical competence. However, this means that the FSE competence requirements specifically related to company's own technology, products and services remains more an untouched area. Nevertheless, both the literature and the findings from the studied cases concertedly highlighted the importance of both technical as well as non-technical competence that is critical competence for the FSE and that should be assured. The FSE's soft (or relational) skills that according to the literature review affect the service quality especially were on the other hand not considered in the case organizations' FSE certification.

9.1.2 Concluding the thesis findings

Following the discussions above, the findings of this thesis are further summarized here based on both the theory and empirical research conducted:

1. Professional certification for maintenance personnel offered by third parties is not utilized in the case organizations. Furthermore, the literature criticized professional certification for lacking practical competence assessment and focus, thus making them not preferred method for companies to assure their maintenance personnel competence;
2. Internally standardized FSE (field service engineer) personnel certification seems an emerging trend, based on the multiple case study on company practices globally. In two of the five cases, the industrial services organizations recently started and developed in-house certification programs for certifying FSE competence roles to support achieving business goals and enhance competence visibility;
3. Industrial maintenance service companies also practice accredited certification of their maintenance service personnel, where the certification activity run by the company itself is approved by an external authority (industry or government body). This was not anticipated from the reviewed literature. However, in three out of the five globally studied cases, this was the situation. The requirements from industry authorities and customers played an important role in leading a company to accredited certification;
4. The FSE personnel certification was said to benefit companies by enhancing their internal efficiency and providing quality assurance on the performed service work and the FSE competence. For the accredited certification cases, the FSE certification further provided assurance on safety and useful legal evidence on the FSE competence development and assessment. The internally standardized certification

cases further assumed that enhanced service quality resulting from the FSE certification will eventually lead to increasing the service business;

5. Personnel certification comes with significant time and resource tradeoffs, and both the reviewed literature and the challenges encountered in the studied case certifications support this statement. Furthermore, in general for the studied cases, the personnel certification was experienced challenging;
6. The reviewed literature emphasizes that the service quality is largely based on how the customer perceives the delivered service, and furthermore, the FSE's soft (or relational) skills are considered critical for the customer encounters and in creating service quality. However, in the studied cases the FSE's soft skills were not considered, and the focus was primarily on assuring technology and product specific competences, and other competences related to the QEHS policies and procedures, workplace communication, and teamwork.

9.2 Managerial implications

The findings from this study indicate that personnel certification is taking place in industrial maintenance service companies. In the presence of dominant external drivers or factors, companies have integrated accredited certification. As for companies, where the external pressure for personnel certification was not present, the companies developed internally standardized certification programs for their own needs to primarily support business goals achieving and competence visibility inside the company. Hence, there is evidently some emerging interest and need for the FSE certification in industrial service companies, and need for registration of data from competence development and assessment. Nevertheless, the experiences from personnel certification in industrial maintenance services are not covering a very long period of time – only some years for most of the studied cases.

This study provides a framework for evaluating the benefits and tradeoffs related to different approaches to running in-house personnel certification, and company's ability to pursue it. Figure 23. presents four (4) steps for evaluating different approaches to personnel certification in companies. The steps are based on the multiple case study findings.

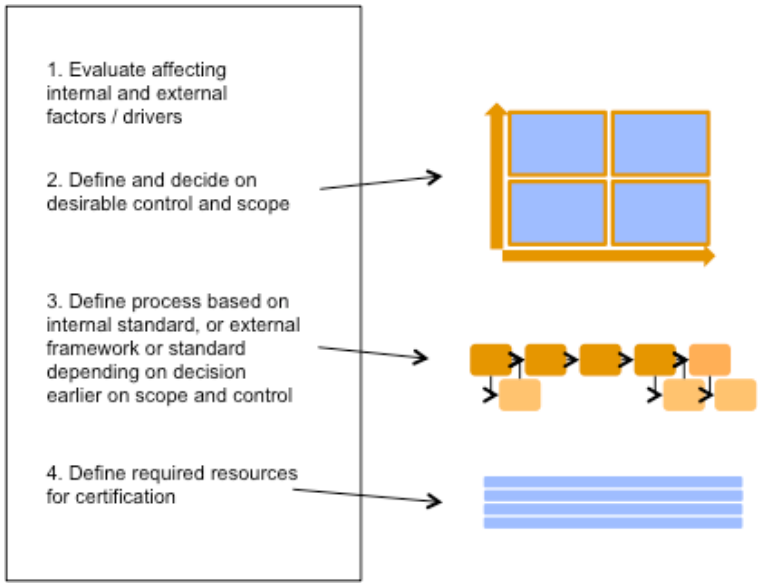


Figure 23. Steps for evaluating different approaches to personnel certification in companies

9.3 Implications for existing literature

The findings from the conducted multiple case study provides new knowledge for both the competence management field, and the research field of industrial services and maintenance services in general. Based on the multiple case study findings, companies have integrated personnel certification as a competence assurance method in their competence management practices. This is in line with the reviewed literature (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Mathieu, 2001; Oliva & Kallenberg, 2003; Brax, 2005; Baines et al., 2008), which state that the shift of servitization of manufacturing and entering industrial maintenance service business has created new challenges for companies that have triggered the need to focus more on managing the intangible assets and the service personnel. Personnel certification practices can be thus assumed to be a result from this change in focus. Furthermore, the reviewed literature emphasized the FSE's soft skills in creating service quality for the customers (Bowen et al., 1989; Matthyssens & Vandenbempt, 1998; Nguyen, 1998; Peterson et al., 2004; Kutvonen, 2012). However, these skills did not stand out in the conducted cases, where the focus was primarily given to assuring technology and product specific competences, and other competence related to the QEHS policies and procedures, workplace communication, and teamwork.

The reviewed literature on competence assurance methods and method elements (Wiley, 1995; Robertson, 1999; Lysaght & Altschuld, 2000; Biggs, 2003; Newstead, 2003;

Baartman et al., 2006; Joosten-ten Brinke et al., 2007) was mainly in line with the findings from the multiple case study. However, new and detailed knowledge on personnel certification practices taking place in industrial maintenance service companies was provided by this study. In the presence of dominant external drivers and factors, the companies had integrated accredited certification. These dominant authorities existed in Australia and South Africa at least. As for companies, where the external pressure for personnel certification was not present, the companies developed internally standardized certification programs for their own needs to support business goals achieving and competence visibility inside the company. Furthermore, all case companies highly valued practical assessments as preferred assessment method for assuring field service engineer's competence on performing service tasks.

Also it can be assumed, that the findings from this thesis study could be applicable on some level to personnel certification as competence assurance method in intangible assets and competence management practices of companies regardless of the field of business, and not limited to industrial maintenance services field only.

9.4 Limitations of the study and suggestions for further research

As this study was qualitative in nature, attention to research design was given to promote the validity and reliability of this study, regarding both the collecting and analyzing the data, and the results of the study. However, some limitations of the study exist.

Identified limitations comprise following: basically only one person per case was interviewed; this study was conducted as an assignment for the company A, and three of the five cases at the time of interview were organizations within the company A, thus this creates possibility that the informants in these cases have intentionally left some information out or put excessive emphasis on some information; one of the five cases also differed somewhat from the other cases as the case company was an aircraft maintenance organization doing business on a highly regulated field and the personnel competence management was controlled by law, this might have caused some level of distortion in the multiple case study findings. On the other hand, considering differing cases probably resulted in more rich and versatile insight about the existence of this phenomenon of personnel certification in industrial maintenance services.

Furthermore, the objective for this research was to study if personnel certification is beneficial for companies in industrial maintenance services, and in assuring field service engineer (FSE) competence in the industrial maintenance services especially. However,

the thesis findings emphasize more the competence assurance methods and content (RQ1, RQ3), not the benefits (RQ2). This is assumed to be resulting from two factors: 1) lack of accurate knowledge on competence assurance and personnel certification practices from the (reviewed) literature, and 2) in most of the studied cases the personnel certification was either recently developed or implemented, or experiences from running the program was only few years. Furthermore, from the multiple case study the benefits were derived from the perceptions and assumptions of single case informants.

Based on the discussion above, suggestions for further research include:

- New case studies with similar study scope could be conducted in order to further investigate the phenomenon of competence assurance and personnel certification practices in companies, and adding knowledge to either support or contradict the findings from this study;
- Further case study on the internally standardized certification cases, A3 and B1, could be conducted to study the experiences some time after the implementation in order to especially evaluate the FSE certification benefits and challenges in more detail;
- Other interesting research topic could be about studying the possibilities of how ”a certified FSE” could be utilized as a service sales pricing criteria.

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11. APPENDICES

Appendix 1: Case interview questions

PURPOSE

- Why was the certification program taken into use? How long has it been used? Were customers expecting certification?
- Who are involved in the certification program? Who is being certified, who is assessing, who manages, who administrates, etc.? What roles are responsible for the certification program?

CRITERIA

- What kinds of skills are assessed?
- What are people being assessed against? Is there a defined set of criteria? What was the process for defining the criteria for assessments? Who, what, where, when? How often are these criteria revised?

ASSESSOR

- Who are doing the assessing?
- How are these people selected?
- How are these people trained and supported? How is the assessor quality monitored?

ASSESSMENTS

- How are the assessments conducted? What kind of assessment tools and methods are used? Where are the assessments conducted?
- How are the assessments verified? Do you have knowledge tests, behavioral tests, other?
- What data is recorded and where? Is someone globally responsible for data quality and storage? How privacy and data protection issues are handled?

CERTIFICATION

- Are there different certification levels? How are they defined? Are international standards and requirements included in certification?
- How long are the (internal) certifications valid? How many certifications are done per year?
- What is the outcome from certification? Work permit? Is there any rewarding related to the certification? What kind of? Who monitors rewarding?
- How much training is related to one certification?
- What are the costs from certification program? Cost per certification? Who pays and what (globally / locally)?

PROGRAM REVIEW/ MONITORING

- How is the certification program reviewed? What is done to find out does it work, and are the targeted benefits achieved?
- What is measured and why? How do you measure the certification program quality?

MOTIVATION

- What is done to motivate people involved in the certification program? Are people motivated? Is certification motivating employees in their career development?

FINAL QUESTIONS

- What have been the benefits from the certification program? Were the expectations met? What has not been working in the certification program? Have you received customer feedback on certification program? If yes, what kind of feedback? Has certification had effects on customer relationships?
- Have you noticed differences in work quality after starting certification?
- Is there any other knowledge that you would like to share? Any information that would be relevant for the topic? Any concerns?

Appendix 2: Case data collection details

	Case type	Case country	Time of case interview(s)	Interviewed person(s)	Type of interview
Case A1	Authority accredited certification of service engineers/technicians and operators including sub-contractors for quality and safety assurance	South Africa	July 2013	SHE Manager (head of certification activity)	Face-to-face interview in Finland Emails to later confirm some obscurities
Case A2	Authority accredited certification of a service division personnel and mine services short term labor for quality and safety assurance	Australia	June-July 2013	Site Environment & Safety Manager (head of certification activity), and Training Coordinator (administrator for certification activity)	Collaboration tool call (recorded, transcribed) Emails later to confirm obscurities (with Training Coordinator)
Case A3	Planned and developed internal program of service technician certification for business plan achievement and standardized competence development in one customer support operations organization	Australia	April 2013	Training Manager (developer of the certification program)	Collaboration tool call (recorded, transcribed) Emails later to confirm obscurities
Case B1	Internal certification of services function engineers/technicians for increasing competence transparency and quality in a locations globally	Finland	April 2013	Project Manager (responsible for the development and implementation of the certification program)	Face-to-face interview in Finland, case report revised and approved by interviewee via email
Case C1	Authority accredited certification of aircraft maintenance mechanics/technicians for legislation compliance and quality assurance	Finland	May 2013	Head of Compliance control (head of certification activity compliance)	Face-to-face interview in Finland, case report revised and approved by interviewee via email

Appendix 3: Competence being certified in cases

TECHNICAL COMPETENCE:

Case A1	Case A2	Case A3	Case B1	Case C1
Operators training (content N/A)	Mill lining (content N/A)	Inspect	Installation and commissioning	Replacement
		Repair	Maintenance	Repair
		Supervise installation	Overhaul repair	Special tasks
		Supervise commissioning		

NON-TECHNICAL COMPETENCE:

Case A1	Case A2	Case A3	Case B1	Case C1
N/A		Apply company values		
	Work safety, OHS policies, risk control, maintain and monitor site quality	Apply safety focus	EHS	Human factors, Occupational safety, Hangar work, Airport work
		Apply customer focus		
	Workplace communication	Communication in the workplace		Human factors
	Environmentally sustainable work practices			

Appendix 4: Scope of certification in cases

SCOPE FACTOR	Case A1	Case A2	Case A3	Case B1	Case C1
Amount of employees in focus	5-10 qualifications per year	**100-300** people trained per year	20-30	**4000**	**350**
Employee group	Operators and customer service technicians, engineers (employees, sub-contractors)	Mill relining division and mine services short term labor	Service technicians	Service technicians and engineers	Maintenance personnel
Locally vs. Globally	Locally	Locally	Locally	**Globally**	Locally (+global sub- contractors)
Complexity of certification framework and leveling	**High** National qualification levels 1-10	**High** National qualification levels 1-10	Low Profile levels from service technician to (supervising) service engineer D,C,B,A	**High** 6 role levels (technician, senior, engineer, senior, superintendent, senior)	**High** Competency categories A,B,C
Number of certificates	Qualifications for operator competences	2 qualifications, 11 units of competence, 3 qualifications to be added	3 profile certifications (for level C,B,A)	**Huge amount of certificates and sub-certificates**	Reduced to 11 authorizations, 27 qualifications
Amount and type of certified competences	**Medium** **Technical**	**Medium** **Generic technical / Non-technical**	**Medium Technical** **Non-technical**	**Wide** **Technical**	**Very wide Technical** **Non-technical (human factors)**
Offering certification service	No	**Yes**	No	No	No
SCOPE:	**NARROW**	**NARROW / MEDIUM**	**NARROW**	**WIDE**	**MEDIUM / WIDE**